The Australian Wine Research Institute Annual Report 2006

Board Members

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

Mr J.F. Brayne, BAppSc(Oen)
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 P.F. Hayes, BSc, BAppSc, MSc, DipEd
Elected a member under Clause 25.2(d) of the Constitution (until 31 December 2005)

Mr T.W.B. James, AssDip(WineProd)
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
Elected a member under Clause 25.2(d) of the Constitution (from 1 January 2006)

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

Associate Professor C.C. Steel, BSc(Hons), PhD
Charles Sturt University Representative under Clause 6(c) of the former Articles of Association (until 21 November 2005)

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

Dr R.R. Walker, BAgSc(Hons) PhD
CSIRO Representative under Clause 6(a) of the former Articles of Association (until 21 November 2005)

The Company

The Australian Wine Research Institute was incorporated under the South Australian Companies Act on 27 April 1955. It is a company limited by guarantee, it does not have a share capital and it has been permitted, under licence, to omit the word 'limited' from its registered name.

The Constitution of The Australian Wine Research Institute (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 wine industry.

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

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

Values
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 industry 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 (AGRF), Australian Grain Technologies (AGT), Australian Wheat Management, BiometricsSA, three different Cooperative Research Centres (CRC), including the CRC for Viticulture, 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

Waite Road, Urrbrae, SA 5064

Postal Address:
PO Box 197,
Glen Osmond,
SA 5064

Telephone (08) 83 03 66 00
Fax (08) 83 03 66 01
Internet www.awri.com.au

ABN 83 007 558 296

52nd Annual Report
30 June 2006

Presented to
the Australian wine industry

Chairman's report

During the past year, the AWRI celebrated its 50th Anniversary, having provided research, development and extension services to the Australian wine industry since 1955.

High on the list of activities to celebrate the jubilee year, was an extended program of seminars and workshops aimed at communicating research outcomes to a broader audience in the industry. A total of 17 workshops were conducted throughout Australia and on a broader base a total of 318 oral presentations were given by our staff.

Other significant events during the year signal that it was a year of substantial change, the details of which will set directions for the AWRI for at least the first part of the next 50 years.

A comprehensive business plan was completed for the AWRI which maps out our immediate future. This plan is wide ranging and detailed, and was compiled, and therefore comprehensively understood and ultimately owned by our key staff – it sets the background scene for more detailed planning of research activities.

The first research prospectus produced by the industry's Strategic Directions Group was unveiled to the industry during the course of the year. The AWRI welcomed this as the first ever comprehensive prospectus for the industry's new research needs and it was used as the principal template for the AWRI's Seven-Year Research, Development and Extension Plan. This plan, a document of some 347 pages now becomes the prime blueprint for our research activities for the next seven years.

The Executive Summary of the plan has been sent to all levy payers with a view to informing them more comprehensively of the research and extension directions being taken by the AWRI. The plan has also become the basic format which drove the seven year investment agreement recently agreed with the GWRDC.

Of all the activities during the past year, the development of the Wine Innovation Cluster (WIC) promises to be one of the most significant for wine industry RD&E. The completion of the WIC building agreements will now enable construction of a new home for AWRI collocated with its partners in the cluster.

The grant of $9.5 million by the Government of South Australia towards the WIC building has been the catalyst to successful engagement of our partners, and although there has been a great deal of focus on the building plans and negotiations, the building is the small part of the picture. It will be the vehicle to permit the AWRI and its fully engaged partners in the Wine Innovation Cluster to build a critical mass of RD&E capability to the benefit of Australia's wine industry, and be the base from which further collaborations, nationally and internationally can be fostered.

The planning activities outlined above demanded very substantial commitments of time and energy of our senior staff, particularly from our Managing Director, Professor Sakkie Pretorius. Sakkie has developed a custom of 'sleeping fast', in order to continue to put the required energy and initiative into these projects. The wine industry is indebted to Sakkie and the team of senior staff who have worked through all of these significant projects.

A number of staff appointments have been made as a direct result of the detailed initiatives described in the ten-year Business Plan: Linda Halse has taken the position of HR Manager, Mai Nygaard joined as Group Manager – Analytical Service and Dr Dan Johnson joins us on the first day of the new financial year as Business Development Manager.

Other appointments made during the year include:

Dr Anthony Borneman, Research Microbiologist

Richard Gawel, Research Scientist

Con Simos, Manager Industry Services

Dr Maurizio Ugliano – Microbiologist

We welcome all of our new staff to our eclectic mix of talent and nationalities. To our existing staff members we owe a special commendation: their working environment has become more and more challenging as planning, reporting, problem solving and working space have all added to pressure in their working day.

Over the past year, staff members have been deployed on two major problem-solving exercises relating to technical aspects of wine production. These activities, which AWRI willingly embarks upon at industry request, highlight the fact that industry ownership of its institute make these investigations possible and that the AWRI, as is demonstrated by investigations of this kind, is much more than just a provider of RD&E capability.

The first stages of evolution of the AWRI governance into modern concepts took place during the past year. The Constitution, which will remain under notice as changes in AWRI's role may demand, has been through a process of redefinition to align it with modern governance standards. What was formerly the Council is now the Board and two of the appointed institutional Board positions have been replaced by provisions to appoint two Special Qualification Directors, who by their expertise will complement the skill set of the Directors. We welcomed Paul Conroy, Legal Affairs Director at Foster's as the first of these appointees and at the periodic election of Board members held in December 2005, we welcomed the new appointment to the Board of Steve Millar, Chair of Constellation Wines.

Finally, I would like to record my sincere appreciation to the members of the Board for their patience, wise counsel and constructive approaches to the challenges which faced us in the last year. The structural and organisational achievements of the year will see the AWRI well placed to approach its second fifty years with enthusiasm and confidence.

Robin Day
Chairman

Board notes

Chairman
At the Board Meeting held on 21 February 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 S.B. Millar

Deputy Members of the Board
Mr N.P. Blieschke
Mr L.P. Deans
Dr P.R. Dry
Mr J. Northey
Mr A.N. Sas

Audit Sub-Committee
Mr P.J. Dawson
Mr T.W.B. James
Mr S.B. Millar

Meetings
Ordinary General Meeting
The 51st Ordinary (Annual) General Meeting was held on 21 November 2005.

Special General Meeting
A Special General Meeting was held on 2 May 2006.

Board
The Board of the AWRI met on the following dates: 7 August 2005, 17 August 2005, 22 August 2005, 26 October 2005, 21 November 2005, 21 February 2006, 2 May 2006 and 16 June 2006.

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 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

South Australian Wine Industry Association Inc.

State Departments of Agriculture

State Government of South Australia

The University of Adelaide

Victorian Wine Industry Association Inc.

Vineyards Association of Tasmania Inc.

Wine Grape Growers Australia

Wine Industry Association of Western Australia Inc.

Winemakers' Federation of Australia Inc.

Managing Director's report

In 2005, The Australian Wine Research Institute celebrated 50 years of existence with a commemorative book, *Advances in Wine Science,* 17 half-day seminars country-wide, and a festive function for our stakeholders. It was not only a time for celebration of past achievements; it was also a time of reflection. At the end of our first 50 years, the AWRI ranks among the top wine research organisations in the world and is a unique model for the provision of high level, industry-relevant research, development and extension (RD&E) services to its owners, the Australian wine industry. The AWRI is proud of its delivery of invention and innovation for the benefit of the Australian grape and wine industry and of the role that it has played in the phenomenal success of the industry over the last 50 years. However, we also realised that, even if we are on the right track, we'll be run over if we stagnate; it is a never-ending race where the objects in the rearview mirror are always closer than they appear.

So, with the dawning of 2006, the AWRI shifted its focus towards the future. We asked ourselves the questions 'how can we improve?' and 'how can we raise the bar for the next 50 years?' As a result of this internal review process and extensive consultation with our stakeholders, we prepared a 10-year Business Plan, *Towards 2015*. The *raison d'être* for this long-term strategic plan is to have an agreed roadmap and a compass with which the AWRI can chart its course for the next decade. The Plan identified where the AWRI finds itself after 50 years of operation; where the AWRI wants to be in ten years' time; the opportunities facing the AWRI; what might prevent the AWRI from realising these opportunities; and how the AWRI might overcome these roadblocks to achieve its goals. The Business Plan states that the *purpose* of the AWRI is to contribute in a measurable way to the ongoing success of the Australian wine industry, and that we are resolute in our *vision* to deliver high value to our industry through world-class research and integrated solutions and to provide 'thought leadership' to the research activities of the Australian grape and wine industry. Our *mission* is to underpin that 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. We reaffirmed the *values* that will provide guidance in how the AWRI will deliver on its mission, i.e. scientific integrity and excellence; a culture of delivering results; internally and externally collaborative; accountability and transparency; and focused on the Australian grape and wine industry and industry driven. The Business Plan identified 10 key initiatives, which will form the basis for the AWRI's operational affairs between 2006 and 2015. These initiatives are aimed to enhance the AWRI's delivery of outcomes, whose words match its performance – an 'organisation of first choice' for our industry stakeholders, investors, staff, partners and suppliers.

As part of these initiatives, it was identified that the AWRI needed to ensure that its research, development and extension (RD&E) priorities are constantly reviewed and revised to align with current industry priorities. To create maximum return on investment, the AWRI prepared a comprehensive, fully-costed seven-year RD&E Plan that responds to priorities recently stated in the research prospectus, *Investing in innovation,* developed by the industry's 'Strategic Directions Group' [formulated by the Winemakers' Federation of Australia (WFA), the Wine Grape Growers Australia (WGGA) and the Grape and Wine Research and Development Corporation (GWRDC)], and those priorities identified by GWRDC and the Australian government's *National Research Priorities.* Guided by the AWRI's Business and RD&E Plans, the AWRI has developed an historic seven-year Investment Agreement with the GWRDC, the principal investor in grape and wine RD&E activities, on behalf of Australia's winemakers and grape-growers, with matching funding from the Australian Government. As an 'industry-owned' company, our RD&E Plan, supported by the GWRDC Investment Agreement, will enable the AWRI to take the lead in promoting a nation-wide collaborative and cooperative research network with a 'whole-of-chain' capability, i.e. outcome-driven RD&E activities that are adequately integrated across the whole supply/demand chain and in line with the Australian wine industry's credo of 'a total commitment to innovation and style from vine to palate'.

To extend the scale and reach of our planned RD&E activities and to maximise the AWRI's contribution to a national cooperative grape and wine research network, we are already working to develop further collaborative linkages with other research providers. One strategy is to establish collaborative nodes in each of the other states; the other strategy is to consolidate the South Australian grape and wine RD&E efforts within the Wine Innovation Cluster (WIC) on the Waite Precinct. The WIC, consisting of The University of Adelaide, CSIRO Plant Industry, Provisor, South Australian Research and Development Institute (SARDI) and AWRI, is a key platform from which we intend to form alliances both within and beyond the 'bricks and mortar' of WIC. The focus of the past year has been on obtaining the funding required for state-of-the-art physical infrastructure and on developing and signing strong agreements that guide how the WIC partners will interact.

I am very proud of these outstanding documents and the staff who created them. It was a true team effort and provides for a comprehensive roadmap that will lead the AWRI into the future. However, I acknowledge that these landmark AWRI Plans and Agreements were prepared against a backdrop of an Australian grape and wine industry that is currently in 'heavy sand'. It is one thing to talk about and to produce fantastic plans, it is another thing entirely to 'walk the talk' – the AWRI is resolute in its intention to implement these plans and, in doing so, to make a real and meaningful contribution to assisting the Australian wine industry to remain competitive in the global marketplace.

Complex industry problems like oversupply require innovative solutions. Innovation has been defined as 'change that adds value', and there is no doubt that AWRI has, and will continue to produce inventions and discoveries that lead to value-creating change in the hands of Australian winemakers and grapegrowers.

Innovation can come from a variety of sources, and it is not necessary to invent something to have an innovation – it can come from a simple mistake or observation, or application of principles from a different industry. Nevertheless, a well-balanced mix of frontier, strategic and applied research is a key driver of *transformational* innovation. It produces sudden, dramatic increases in understanding, new practices and techniques, and new products which, when applied in industry, are translated into innovation. Such transformational innovation will allow the Australian wine industry to produce wines of higher value and/or, in the case of oversupply, wines which are preferentially sought in the global marketplace. It is the rapid adoption of these research outcomes that will keep the Australian industry in front of the global pack.

Australia houses a strong R&D capability in the wine industry, but R&D funding providers and the Australian Government need to fast-track research programs which can address current issues, including oversupply. Our RD&E Plan focuses our efforts within four themes: (i) Grape and wine composition; (ii) Grape and wine production; (iii) Wine in society; and (iv) Information and knowledge transfer.

When I look back over this last year, I feel a great sense of satisfaction at what 'Team AWRI' has achieved and the plans and agreements we have put in place for the future. Once again, a big thank you must go to the talented staff members of the AWRI. Without their dedication and hard work, the AWRI would not be the world-renowned organisation it is today. I would also like to thank the AWRI Board of Directors for their enthusiasm and support and their commitment to R&D in the Australian wine industry. Special thanks goes to our Chairman, Robin Day, whose wise counsel, advice and commitment have helped me enormously throughout this challenging year.

I am also grateful for the continuing contribution and support of the Australian wine industry and the GWRDC, through which the AWRI's projects are funded by the levies paid by Australian's winemakers and grapegrowers with matching funding from the Australian government. We also appreciate the supportive relationships we enjoy with WFA, WGGA, AWBC, ASVO, WISA and PIRSA and the more than 24 domestic and international individuals and organisations whom we collaborated with this year.

For the coming year, we are looking forward to concentrating on our core work – inventive, innovative science that will advance the Australian wine industry. We are looking forward to 2007 and the years beyond that. As Alan Kay once said "The best way to predict the future is to invent it".

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.,* Personal Assistant to the Managing Director

Corporate Services

Hans Engelbert Muhlack, BEc *UAdel.*, CPA Aust., Company Secretary

Linda Joy Halse, BA, Post Grad (Dip Ind. Rel.) *UNatal*, Human Resource Manager (commenced 12 September 2005)

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

Rachel Lee Edwards, Accountant

Holger Gockowiak, BSc(Hons) *UAdel.*, OHS&W Coordinator

Rhonda Irene Milde, Administration Officer

Mark Raymond Braybrook, Operations Project Officer (commenced 29 August 2005)

Pauline Jorgensen, Administration Support Officer

June Robinson, Administration Support

Jeanette Fay Tooley, Administration Support

Communication and Information Resources

Raelene Joan Blair, CertAppMgt(Marketing) *AIM*, MAICD, Group Manager Communication and Information Services

Catherine Grace Daniel, BA *ANU*, GradDip(Lib) *RMIT*, Librarian

Ingrid Betty-Maud Barratt, DipLibInfo *Adel. Tafe,* Library Technician

Melissa Elizabeth Francis, BA *UMelb.,* DipEd *Melb. State Col.,* Library Assistant

Claire St George, Library Assistant (commenced 18 April 2006)

Kathryn Sarah Beames, Conference Secretariat

Research

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

Heather Margaret Donnell, Administrator – Research

Paul Joseph Chambers, BSc(Hons), PhD *Hertfordshire,* Principal Research Molecular Microbiologist

Ian Leigh Francis, BSc(Hons) *Monash,* PhD *UAdel.,* Principal Research Sensory Scientist

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.,* Principal Research Biochemist

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.,* Research Microbiologist

Anthony Richard Borneman, BSc(Hons), PhD, *UMelb.,* Research Scientist (commenced 1 May 2006)

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

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

Richard Gawel, BSc *Adel,* DipEd *Adelaide,* GradDipOenol. *Roseworthy,* Research Scientist (from 1 February 2006)

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

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

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

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

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

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

Jan Hendrik Swiegers, MSc, PhD *Stellenbosch,* Research Molecular Biologist

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

Maurizio Ugliano, PhD *Foggia,* Microbiologist (commenced 28 November 2005)

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

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

Kate Alexandra Lattey, BSc *Canterbury,* Sensory Scientist

Meagan Diane Mercurio, BSc(Hons), BTech *Flinders,* Chemist (commenced 1 August 2005)

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

Tracey Ellen Siebert, BSc *UAdel.,* Chemist

Brooke Travis, BAgSc(Oen) *UAdel.,* Sensory Scientist (commenced 9 January 2006)

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

Jennifer Rose Bellon, Technical Officer

Angus Henderson Forgan, BSc(Hons) *Flinders,* Technical Officer (commenced 4 July 2005)

Maria Jolanta Kwiatkowski, MSc *Gliwice,* Technical Officer

Belinda Ruth Bramley, Sensory Technician

Kevin Herbert Pardon, AssDip(AppChem) *SAIT,* Laboratory Technician

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

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

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

Industry Development and Support

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

Narelle Elizabeth Cream, Administrator – Industry Services

Con Arthur Simos, BAppSc(Oen) *Roseworthy,* Manager – Industry Services (commenced 1 May 2006)

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

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

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

Emma Kennedy, BSc(Comput Modell) *Flinders,* Analyst (commenced 12 December 2005)

Mark Gishen, BE (Chem)(Hons), MEngSc(Chem) *UMelb.,* Quality Liaison Manager

Robert George Dambergs, BSc(Hons) *UAdel.,* PhD *UQld,* Senior Research Chemist

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

Wieslawa Cynkar, BSc, PhD *Wroclaw,* Technical Officer

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

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

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

Analytical Service

Mai Nygaard, MSc *UCopenhagen,* Group Manager – Analytical Service (from 5 December 2005)

Peter Charles Hans Eichinger, BSc(Hons), PhD *UAdel.,* Manager – Analytical Service (concluded 23 September 2005)

Sandra Margaret Lloyd-Davies, BA *Flinders,* Customer Service Manager

Maria Concettina Mills, Customer Service Officer

Jelena Jovanovic, Customer Service Officer

James Matthew McIntyre, BSc U*Adel.,* Dip BM, Analytical Laboratory Supervisor (commenced 22 May 2006)

Matthew James Cream, Project Manager

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

Carol Jean Sigston, BAgSc *UAdel.,* Laboratory Technician

Slavko Matthew Bekavac, Laboratory Technician

Danielle Marie Butzbach, BTech (For's & Analyt Chem) *Flinders,* Laboratory Technician (commenced 9 January 2006)

Danielle Kylie Leedham, Dip. AppChem, Laboratory Technician

Daniel Scott Tynan, DipAppSc, *USthAust.,* 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

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

David Rolfe Boehm, BSc *UAdel.,* Technical Officer

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

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

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

Eric Denis, *Flinders,* PhD Student

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

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

Oenone Jean Macintyre, BSc, BE(Chem) (Hons), *UAdel.,* PhD Student

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

Inmaculada Blazquez Rojas, PhD, *UCastilla-La Mancha,* Visiting Researcher (Spain)

Anna-Maria Molina, BBiochem, *Pontificia U Católica de Chile,* Visiting Postgraduate student (Chile) (concluded December 2005)

Steven van Sluyter, BA, BSc *UNthCarolina,* Research Student (USA)

Claudia Wood, *Pontificia U Católica de Chile,* Visiting Postgraduate Student (Chile)

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

1. **The production and distribution of the AWRI's commemorative book** *Advances in wine science – commemorating 50 years of The Australian Wine Research Institute.* The publication contains 16 review papers covering areas relevant to AWRI's work. Copies have been made available for sale via the AWRI's website *(www.awri.com.au).*

2. **The conclusion of a 12-month process to develop a strategic ten-year Business Plan** for the AWRI *Towards 2015.* The Business Plan was adopted and presented to key stakeholders.

3. **As an initiative from the Business Plan, the development and completion** of a *Seven-Year Research, Development and Extension Plan 2006-2013.* This research plan was presented to industry members in South Australia, and will be presented in other States.

4. **The negotiation and completion of the Wine Innovation Cluster Project Charter** and Agreement to Lease. The development of the floor plans are continuing.

5. **As an initiative from the Business Plan, the Constitution of the AWRI** was updated to include modern corporate legislation and amended to assist the transition of the AWRI's Council to a skills-based corporate Board.

6. **Four patents have been granted** for innovations in relation to the use of spectroscopy for compositional analysis in the wine industry.

7. **The use of Vis-NIR spectroscopic technology for the determination** of red grape composition (total anthocyanins, total soluble solids and pH) that has been developed at AWRI within the CRCV has achieved a significant milestone with the establishment of continuing commercialisation agreements.

8. **An industry 'standard' laboratory method for the measurement of the concentration** of total anthocyanins in red grapes has been published and disseminated by the CRCV and endorsed by the Winemaker's Federation of Australia.

9. **Provision of urgent problem-solving and analytical assistance to Australian wine producers,** preventing the potentially widespread contamination and tainting of wine from a number of exogenous sources, and enabling the quarantining of affected wines. Sensitive and robust analytical methods were developed for the quantification of a number of compounds contributing to observed taints, some of which have apparently not previously been reported as the cause of taints in wine.

10. **Provision of urgent analytical assistance** to the industry for the 6-CC taint and ongoing analytical support in common wine taints.

11. **Low alcohol yeast – proof of concept.** A selection process has been successfully devised and tested for selecting natural variants in a yeast population which produce less alcohol from a given amount of sugar than the parental strain.

12. **Development, adoption and application of new, industry applicable methods for tannin measurement.** The method for grape and wine tannin analysis by precipitation with methyl cellulose is now fully optimised, validated and available to industry and researchers alike in 1 mL, 10 mL and high throughput formats. A standard operating protocol is available on request and the assay has been made commercially available through the AWRI Analytical Service.

13. **As a result of our ongoing work on the applications of rapid methods** to sensory analysis, and in collaboration with DPI Queensland (Heather Smyth), a study entitled *Potential of VIS-NIR spectroscopy to predict perceived 'muddy' taint in Australian farmed barramundi* was honoured with the 'Lynsey Ann Welsh Award for Innovation in NIR Science'. Both The Australian Wine Research Institute (Rapid Analytical Methods team) and DPI were awarded as an example of collaboration on this innovative area of application of NIR spectroscopy.

Highlights of the year

14. **Completion of the genetic characteristion of 244 *Dekkera bruxellensis* isolates from 30 Australian wine regions,** revealing eight distinct strains, the genetic diversity of which is greater than that previously reported for the entire *Dekkera* genus.

15. **The Analytical service performed more than 100,000 individual analyses** for the Australian wine industry, covering a wide range of sample types and parameters. New services, like the MCP tannin assay, were added to the comprehensive list of analytical tools available to assist grape growers and winemakers, and routine analysis on wines became automated through implementation of NATA accredited FTIR and FIA methods.

16. **A new state of the art Laboratory Information Management System** (LIMS) in Analytical Service ensures efficient handling of customer samples, optimal data management and improved work flows. The system is customized to meet current as well as future needs of Analytical Service and its customers, including the highest standards in quality management and traceability. Customers will also see direct benefits from the LIMS through intro-duction of new services like electronic notification and reporting.

17. **The Viticulturist responded to 432 enquiries.** The majority (80%) were regarding the use of agro-chemicals 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.

18. **Eleven thousand copies of the AWRI's annual publication,** *Agrochemicals registered for use in Australian viticulture 2005/2006* 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*. The 2005/2006 MRLs for Australia's major export markets were updated for the AWRI website.

19. **The common spray diary format,** developed in conjunction with industry, was accepted as an industry minimum standard by the Agrochemical Reference Group and by WFA for 2005/2006.

20. **The first large consumer preference mapping study** carried out by the AWRI on Cabernet Sauvignon and Shiraz red wines provided a fascinating, detailed insight into Sydney consumers' likes and dislikes, demonstrating that wines with *Brettanomyces* flavour are generally disliked by consumers, and that the consumer population tested can be segregated into distinct preference groups.

21. **AWRI published** 93 papers on AWRI activities in refereed and non-refereed publications (a 76% increase over the previous year).

22. **AWRI staff members gave** 318 oral presentations (an 84% increase over the previous year), conducted 6 workshops and presented 21 posters.

23. **AWRI staff members presented** 50 lectures and coordinated a six week subject to undergraduate students.

24. **AWRI staff members** supervised/co-supervised 19 postgraduate students.

25. **AWRI staff members recorded** and responded to 6,442 requests for information during the 2005/2006 year or, to put the statistics into perspective, 26 people contacted the AWRI seeking information on every working day of the year. This figure does not include the amount of problem samples investigated (2,630; a 52% increase over the previous year) or the number of Analytical Service analyses undertaken (>100,000; a >55% increase over the previous year) during 2005/2006.

26. **Staff of the John Fornachon Memorial Library** responded to 4,011 requests for information during 2005/2006.

27. **Over 5,000 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 37,000 records available for searching, 24 hours per day, 7 days per week.

Readers are strongly encouraged to read the report in detail rather than relying on the brief details above for information.

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 Industry Technical Advisory Committee (WFA); the R&D Committee (WFA); 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; Council of the Institut des Sciences de la Vigne et du vin de Bordeaux; the Scientific Committee of the Oenology Research Institute of Calalonia; Editorial Board of the following journals: *American Journal of Enology and Viticulture, Annals of Microbiology, FEMS Yeast Research* and *Yeast*. He is a member of the Management Committee for Viticultural Publishing. He is a Director of Provisor Pty Ltd. He is the Chairman of the Conference Planning Committee of the Thirteenth Australian Wine Industry Technical Conference. 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*. 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, 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 home-page 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 CRCVII. 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.

Peter Godden is a member of the 13th AWITC Program sub-Committee and the Workshop Coordinator of a program of 70 workshops to be held at the Thirteenth Australian Wine Industry Technical Conference. He is also an Associate Judge at the Royal Adelaide Wine Show (since 2001).

Staff activities

Con Simos is a member of the Conference Planning Committee and Program Sub-Committee for the 13th AWITC (Adelaide 2007).

Mark Gishen is a member of the AWBC's Compliance Advisory Committee, leader of project 1.4 of the CRCVII, and is the AWRI's representative on the Winemakers' Federation of Australia (WFA) Legal Metrology Group.

Creina Stockley is an Affiliate Senior Lecturer, School of Agriculture and Wine, The University of Adelaide. She is a member of the Wine Industry Technical Advisory Committee (as Technical Liaison); AWBC Legislation Review Committee (on request); Wine Industry National Environment Committee; CRCV 'Good Environmental Management' Project Reference Group; Australian delegation to the Organisation de la Vigne et du Vin; Nutrition and Wine Expert Group of the Organisation de la Vigne et du Vin (Vice-President); National Drug and Alcohol Research Centre's Young People and Alcohol Project Advisory Group; Scientific Committee, Bordeaux Wine and Health International Congress 2007 (France); Waite Campus Executive Committee/Waite Facilities Services and Amenities Committee; and a Board member of The University of Adelaide's Children's Services Scientific Committee. She was a member of the Vindaba Wine and Health International Congress 2005 (South Africa) and is an International Consultant for the Center for Wine and Cardiovascular Health, University of Alabama (USA).

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. She is also a member of the WIC Technical Reference Group.

Catherine Daniel is a member of the ALIA Special Libraries Section (SA) Branch.

Acknowledgements
Compiled and edited by Rae Blair

Design by Geoffrey Reed Communications

Visitors to the AWRI

International

Argentina
Miguel Remuinan, Miguel Boroni and Daniel Siragusa, National Institute of Viticulture and Oenology, Argentina, 28 November 2005

Austria
Astrid Forneck, University of Natural Research and Applied Life Science, Vienna, Austria, 27 September 2005

Belgium
Pol Coppin, Dean of the Faculty of Bioscience Engineering, Catholic University of Leuven, Belgium, 18 August 2005

Luc Lurton and Olav Aargaard, Nomacorc, Belgium, 26 August 2005

Luc Lurton, Nomacorc, Belgium, 15 November 2005

Sofie Saerens, Catholic University of Leuven, Belgium, 16 February 2006

Chile
Rene Madariaga, Viña Tarapaca, Eugenio Maffei, Viña Corpora, Jorge Rojas, Viña Valdivieso, Ricardo Rodriguez, Viña Santa Rita, Rene Vasquez, Viña Veramonte, Eugenio Cox, Viña L. F. Edwards, Bernhard Frisius, Viña San Pedro, Rodrigo Barria, Viña Montes, Jose Aguirre, Viña Concha y Toro, Francisco Valdivieso, Viña Undurraga, Felipe Letelier, Viña Undurraga, Guillermo Llull, Viña Morande, Stanley Best, INIA, Director PROGAP, Ricardo Rodriguez, Agroprecision Ltda, Chile, 30 September 2005

Denmark
Morten Hassing, KVL, Denmark, 16 March 2006

France
Ann Julien Ortiz, Lallemand, France, 22 September 2005

Dominique Delteil, Consultant, Maurin-Lattes, France, 2-3 Nov 2005

Gilles Pelsy and Vincent Beaumont, Pernod Ricard, France, 2 December 2005

Patrice Desmeret and Marie-Helen Gaudet, Pernod Ricard, 13 December 2005

Celine Barbier, Entav International, France, 15 December 2005

Etienne Besancenot and Florent Girou, Vinorama, France, 20 and 22 December 2005

Jean-Pierre Van Ruyskensvelde, ITV France, Paris, France, 10 March 2006

Laurent Audeguin, ENTAV, France, 10 March 2006

Claude Espeillac, Lallemand, Blagnac, France, 24 March 2006

Jean-Pierre Savinna, Pernod Ricard, France, 10 April 2006

Nathalie Jacquet, Pernod Ricard, France, 2 June 2006

Germany
Sibyll Krieger-Weber, Lallemand, Germany, 31 January, 1 and 13 February 2006

Italy
Dora Marchi, Enosis Italian Wine Research Centre, Dario Cartabellotta, Agriculture & Forestries, Felice Crosta, Agriculture & Forestries, Antonino Colletti, Forestries, Giovanni Lo Bue, Land and Environment, Vincenzo Pernice, Federico Paulsen, Government Vine Nursery, Agostino Porretto, Tourism, Communication and Transport, Paolo Rizzo, Tourism, Donato Lanati, Enosis, Sandro Tatano, Tamaco Tre - Nero d'Avola Festival, Angela Valeria Pace (Interpreter) Tamaco Tre & Nero d'Avola Festival, Sicily, and Sara Covino, Austrade, Milan, 21 March 2006

Korea
Gi-Cheol Song, National Horticultural Institute, Korea, 11 April 2006

The Netherlands
Herman Vedder, BLGG, Oosterbeek, The Netherlands, 17 February 2006

New Zealand
Andy Frost and Philip Manson, Allied Domecq Wines, New Zealand, 20 July 2005

Paul MacGilvray, HortResearch, New Zealand, 19 January 2006

Norway
Adrian Zuffi, CAMO, Norway, 27 February 2006

South Africa
Philip Spies, Creative Futures, South Africa, 16 June 2006

Karien Lourens, Anchor Yeast, South Africa, 1 August 2005

Spain
Luis Zudaire Romano, Bodegas Vinicola Navarra and Ma Florencia Stoppini Adamo, Bodegas Placio de la Vega, Nvarra, Spain, 14 March 2006

United Kingdom
Robert Falconer, Department of Chemical Engineering, University of Cambridge, United Kingdom, 16 November 2005

Roger Leigh, Professor of Botany, Cambridge University, United Kingdom, 13 December 2005

United States of America
Jay Cummins, Nomacorc, USA, 26 August 2005

Kirsten Skogerson, University of California Davis, CA USA, 31 January 2006

Steven Fike, Wine Customs LLC, San Francisco, USA, 22 February 2006

Art Caputi, Art of Winemaking LLC, Washington, USA, 22 February 2006

David Block, Associate Professor, Department of Viticulture and Enology and Department of Chemical Engineering and Materials Science, University of California, Davis, CA USA, 23 February 2006, 31 May 2006

Taylor Russell, World Report, USA, 22 June 2006

Domestic

Greg Organ, Lion Nathan, 2 August 2005

Neil Walsh and Darryn Wolter, Cork Supply Australia, 26 August 2005

Don Lester and Leon Deans, Orlando Wines, 13 December 2005 and 10 April 2006

Terry Cocks, Integrated Spectronics, 4 August 2005 and 22 February 2006

Peter Jones, Allan Long, Ivan Shaw and Phil Chidzey;David Swain & Chris Ellis; Jim Mulan and Brian Thorn, Australian Dried Fruits Association; Sunbeam Foods; Clyne Foods 5 September 2005

Evan Holley, Department of Industry, 26 September 2005

Simon Hamilton, AMCOR Research and Technology, 21 February 2006

Francis Wong, Top8Wines Pty Ltd and Encounter Australia, 6 March 2006

Roger Hartly, Executive Director, Industry Development and Ministerial Liaison, PIRSA, 6 March 2006

Raphael Viscarra-Rossel, Australian Centre for Precision Agriculture, Faculty of Agriculture, Food and Natural Resources, The University of Sydney, 30 March 2006

Melody Lin, Taiwan Trade Centre, Sydney Office and Michael Adams, Peninsula Crossing Pty Ltd, 4 April 2006

Paul Henry and Lucy Anderson, Wine Australia, 4 May 2006

Ian Dawes, University of New South Wales, 29 May 2006

Mick Reid, Facilitator of NCRIS Capability 5.1, 2 June 2006

Peter Fraser, Carlton and United, 7 June 2006

Mike Woods and Steven Kates, Productivity Commission, 13 June 2006

Winemakers' Federation of Australia R&D Committee, Australia, 15 June 2006

Team reports

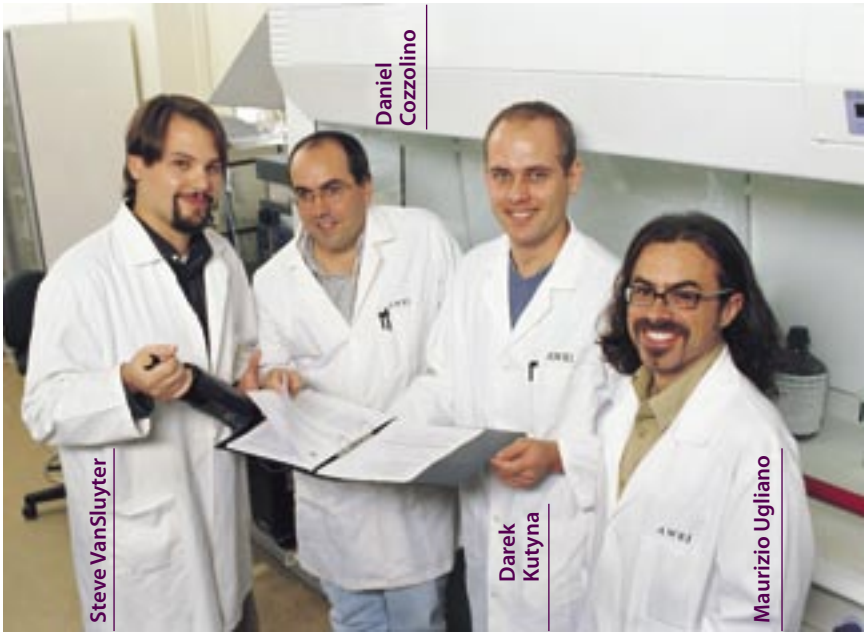
Interactions of non-volatile and volatile compounds in wine: major influences on wine flavour perception

Staff and students

Richard Gawel, Ken Pocock, Simon Schmidt, Paul Chambers, Yoji Hayasaka, Liz Waters (AWRI). Richard Muhlack, Jean Macintyre (University of Adelaide), Steven Van Sluyter (University of Melbourne), Ee Leng Tan, Sam Henderson, Uli Julia Nasution and Nick Warnock (Flinders University).

Collaborators

Simon Nordestgaard, Chris Colby and Brian O'Neill (School of Chemical Engineering, University of Adelaide), Peter Anderson (School of Biological Sciences, Flinders University), Audrey Lim (The Hardy Wine Company), Leon Deans (Pernod Ricard Pacific), Filomena Pettolino and Tony Bacic (CRC for Bioproducts, University of Melbourne).



This project combines research on protein instability in wine with aspects of the sensory consequences of interactions between proteins, and other polymers in wine, with other wine components. Protein haze remains as one of the key potential instabilities in white wine production that requires time consuming and costly treatment with potential losses in overall wine quality. The majority of these costs are associated with the quality downgrading of wine recovered from the bentonite lees. This project addresses the need to develop alternatives to bentonite fining by discovering novel proteolytic enzymes, improving the efficiency of bentonite fining and through a better understanding of the phenomenon of haze formation.

In-line dosing of bentonite

We collaborate with the wine industry and the School of Chemical Engineering, The University of Adelaide, on a project to improve bentonite efficiency. The current wine industry method for bentonite fining involves batch-wise addition of bentonite slurry to wine in a tank. The bentonite particles adsorb residual grape proteins present in the wine so they will not precipitate and form haze or cloudiness in the product after it is bottled. Settling is slow and it can take up to a week before the wine may be racked off solids. Furthermore, the bentonite sediment or 'lees' can occlude between 5 and 10% of the volume of the treated wine. The occluded wine is normally recovered from the lees by rotary drum vacuum filtration. However, oxidation of the wine during this step can lead to a significant downgrade in quality or value loss.

In-line dosing of bentonite followed by centrifugal separation was studied as an alternative strategy to improve the efficacy of the stabilisation process. The testing involved fining of a wine and juice with several different commercial bentonites. Following bentonite injection, a contact period of up to 4 min was allowed before bentonite separation from the wine or juice using an existing industrial disc-stack centrifuge at the winery. Samples were taken from the pipe at different locations, to achieve different contact times after bentonite addition. Fining or treatment performance was quantified with measurement of protein concentration and wine turbidity following a heat test at 80°C for six hours. Stable values of protein concentration and turbidity were achieved within 30 sec to 2 min after bentonite addition. The performance of in-line dosing was compared with batch fining. No significant difference in sensory effect was found. However, optimisation of the in-line dosing and centrifugation process is necessary to prevent carry over of bentonite. Laboratory tests showed that compacting of lees by centrifugation would reduce the volume of occluded wine, and thus, value losses that currently arise by batch fining.

Haze protective factors

An alternative to the removal of haze-forming wine proteins from wine with bentonite involves the addition of polysaccharides with haze-protective activity to wines. Two *Saccharomyces cerevisiae* mannoproteins exhibiting such haze-protective activity (Hpf1p and Hpf2p) have been identified, and, for research purposes, a *S. cerevisiae* strain over-expressing a hexahistidine-labelled form of Hpf2p (6xhisHpf2p) has been produced. We are determining the feasibility of scale-up of a process for manufacture of 6xhisHpf2p through our collaboration with the School of Chemical Engineering and the sensory impact of adding 6xhisHpf2p to wine.

The initial over-expression system resulted in yields of purified 6xhisHpf2p of 5 mg/L. This was sufficient for initial assessment of the activity of the tagged protein but is too low for the current work. Some factors likely to contribute to the low yields that we have examined were the strain background, the low biomass achieved during fermentation and aspects of the fermentation media, including carbon source and pH. When the 6xhisHpf2p plasmid was transformed into a *S. cerevisiae* S288c strain with only an uracil auxotrophy and, all other conditions being identical, this new strain produced a four-fold increase in yield of 6xhisHpf2p compared to the previous strain. We also examined whether better growth and expression could be achieved in a complex rich medium like yeast peptone dextrose (YPD) medium compared to defined media such as synthetic complete media (SCM) and chemically defined grape juice media (CDGJM) as well as other defined media used by other laboratories working on yeast expression. Of the five media considered, CDGJM was found to be best for expression and purification of 6xhisHpf2p. Aspects of the gene induction stage were also examined. Expression of 6xhisHpf2p was similar with raffinose, glycerol and ethanol as the secondary carbon source, with little expression with lactate. As a result, ethanol was the secondary carbon source of choice, due to its low cost compared to raffinose and its ease of use compared with glycerol.

In addition to this work in *S. cerevisiae* in collaboration with The University of Adelaide, we are also collaborating with the School of Biological Science, Flinders University to examine *Pichia pastoris* as an alternative expression system for 6xhisHpf2p. *Pichia* is of interest because it might give greater yields and because the glycosylation profile of 6xhisHpf2p produced in *Pichia* will differ from that in *Saccharomyces*. A preliminary activity assay indicated that the *Pichia* products had haze-protective activity but at a lower level than that of 6xhisHpf2p from *Saccharomyces*. If this difference in activity can be confirmed, this will provide some information on the likely role of glycosylation in the activity of these haze protective factors.

In summary, we have been able to identify conditions that improve expression of 6xhisHpf2p in *S. cerevisiae* and are now at a stage where we can prepare enough material to carry out sensory evaluation in wines.

Proteolytic enzymes

Another alternative strategy to bentonite fining is to remove the haze-forming proteins in white wine using proteolytic enzymes. However, most residual proteins in wine are resistant to proteolysis by commercially available proteases. Recent studies on the effect of fungal infection on protein accumulation in *Vitis vinifera* identified a new promising source of proteases when it was realised that the juice of grapes infected with *Botrytis cinerea* contained very low levels of proteins.

We have both a proteomic and genomic approach to this research project area. We are collaborating with the School of Botany, University of Melbourne on identifying novel proteases from *Botrytis* infection of grapes and with the School of Biological Science, Flinders University to express in *Pichia* some of the aspartic acid proteases of *Botrytis,* and assess their efficacy in grape juice and wine.

The nucleotide sequences of the five known aspartic protease encoding genes in the *B. cinerea* genome are publicly available. It would seem prudent to assess the ability of all *B. cinerea* isozymes to breakdown pathogenesis related (PR) proteins, since it is not known which one, if any are capable of this. However, due to the complexity of the aspartic protease structure, the design of a construct capable of directing expression and secretion of active protease needed to be examined and as such our current work should be considered a preliminary step towards that final goal. A single aspartic protease, was chosen to determine whether *P. pastoris* was capable of expressing a modified genomic version of the selected protease.

The genomic DNA was present in the genome of the *P. pastoris* clones used in this expression study. Despite this, extracellular expression of the aspartic protease was not detected in *P. pastoris.* Further data indicated that the lack of expression was probably due to *Pichia* not being capable of correctly processing *B. cinerea* pre-mRNA. Thus, it appears that a non-functional peptide might have been generated.

In summary, this work was an initial step towards the production, for research purposes, of recombinant *B. cinerea* aspartic proteases and the assessment of their ability to degrade grape berry proteins at room temperature. Genomic DNA of a single aspartic protease isozyme (Bcap5), although successfully incorporated into the *P. pastoris* genome, did not lead to expression, probably due to *Pichia* not being able to correctly process *B. cinerea* pre-mRNA. We have recently received preliminary data indicating that it is possible to re-engineer the construct in a different way and we are currently introducing this construct into *Pichia* for expression studies.

Mechanism of protein haze formation

The mechanism of protein haze formation is not fully understood. Slow denaturation of wine proteins is thought to lead to protein aggregation, flocculation into a hazy suspension and, finally, formation of visual precipitates. Protein added to model wine (an aqueous solution of ethanol and potassium hydrogen tartrate at wine-like pH and ethanol concentration) does not precipitate or produce haze when heated, whereas visually obvious hazes occur when the same protein is added to authentic white wines that had previously been stripped of protein.

The importance of non-proteinaceous factors in white wine protein haze formation such as proanthocyanidins, have been suspected for some time. Other factors such as polysaccharides, alcohol levels and pH have also been implicated.

Our current model of protein haze formation involves two steps (Figure 1). The PR proteins from grape that form haze in wine exist as globular entities freely soluble in wine, together with other wine compounds. The first step is to uncoil or denature the PR proteins. Other wine components, whose identity have not yet been confirmed hence they are called Factor X, are essential to this step, and denaturation is accelerated by heating. The denatured protein then aggregates (the second step of the process) with the size of the aggregated protein particles, and thus their visual presence, depending on cross linking through phenolic compounds, metal ions and other wine solutes. If Factor X is not present, however, heating alone does not result in sufficient denaturation of the proteins to lead to their aggregation.

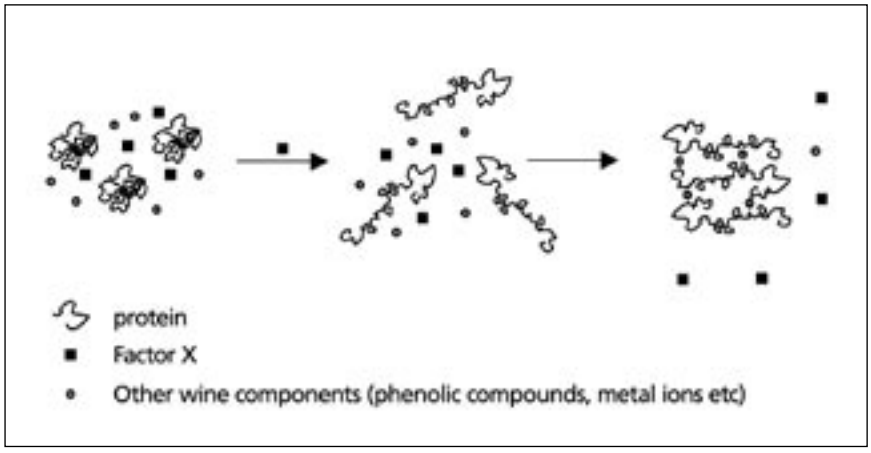


Figure 1. ***Proposed mechanism of protein haze formation in white wine.*** *Wine proteins exist in wine with other wine solutes (Factor X and other wine components). Denaturation of the proteins occurs in the presence of Factor X. The denatured proteins then aggregate together, assisted by cross linking through other wine components.*

Predictive tests for protein haze formation

Based on work undertaken over 30 years ago, most Australian winemakers use a heat test (80°C for six hours) to check white wines for protein stability. Some winemakers consider that this test is too severe, resulting in wines being over-fined with bentonite. We have recently compared the predictive ability of this test, assessed either by eye, by nephelometry or by optical density, with that of two alternative assays (80°C for two hours and the Bentotest), through the use of storage trials of eight wines designed to mimic commercial conditions of transport and storage of wine.

One of the eight unfined wines failed to develop haze even under the more severe storage conditions of this study (35°C for a month or fluctuating between 20°C and 35°C for eight days) and only six of the eight unfined wines developed haze under 'best practice' storage conditions (13°C - 17°C for 16 months). All the wines fined with bentonite at dosage rates determined by the three predictive tests used in the main part of this work remained bright in bottle after storage trials at 13°C - 17°C for 16 months, 35°C for a month or fluctuating between 20°C and 35°C for eight days.

Thus, this study has demonstrated that most of the current predictive assays used by the wine industry could be biased towards overfining. It is also possible that technical errors in performing both the heating and the haze measurement steps might add to their inaccuracy. This could lead to fining with more bentonite than is needed under most conditions encountered commercially by bottled wines during transport and storage. Clearly, further trials with more wines and with storage under a wider range of conditions would be necessary to confirm these results.

The performance of the tests in this study was assessed under storage conditions that might not apply to all wine producers and resellers. We recommend that wineries do not change their current predictive assay techniques until they have rigorously assessed the commercial outcomes of such a change, preferably through conducting long-term storage trials under conditions relevant to their business.

The sensory consequences of interactions of wine components

Our aim in this subproject is to assess the relative importance of major components and component groups that influence the perception of sensory properties of commercial wines either directly or through interactions with other components. The initial experiments involved separating wine component groups, such as phenolic compounds, proteins and polysaccharides, from wine and then assessing the influence of these component groups together with volatile compounds, glycerol and ethanol on the aroma, flavour and mouth-feel of a model wine.

The key criteria for this study were to present realistic 'wine-like' samples to trained evaluators, in such a way that key interactions between components could be identified. This was achieved by either adding wine components at wine realistic levels to a model wine base or by omitting them from the mixture. The complex wine macromolecules (proteins and polysaccharides) were purified from white wine, while the other components (ethanol, glycerol and volatiles) were obtained commercially. Interactions were examined by presenting various mixtures to a trained panel of assessors and asking them to assess the intensity of aroma, flavour, in-mouth textures and tastes.

The data from this study provide hints to what the key interactions might be. Not surprisingly, volatile compounds affected most aroma attribute ratings positively; however, this factor was also involved in interactions affecting hotness and acidity. Interactions between volatile compounds and protein also appeared to be important for several aroma attributes. Further experiments need to be conducted to confirm these and to ascertain the relative importance of them, particularly in light of the fact that white wines are generally fined to remove protein, a process which also alter the concentration of volatile compounds in the wine. In many cases, interactions between effects involving volatile compounds were most prominent when the concentration of volatile compounds was low, suggesting that wines with naturally low levels of volatile compounds are affected more by changes to the factors more associated with wine structure, such as ethanol, glycerol and to a lesser extent polysaccharide level.

There appeared to be relevant interactions between ethanol and glycerol that affected several aroma and mouth-feel attributes. Ethanol appeared to have the greatest enhancing impact on hotness, drying and roughing, which are mouth-feel attributes that can be regarded as 'unpleasant' when perceived in white wine. The effect of glycerol, polysaccharides and protein was dependent on the combinations in which they were found, but in general the presence of glycerol in many cases appeared to reduce the intensity of 'unpleasant' characters such as bitterness. However, the generality of this statement warrants further study before any firm conclusions can be made.

A second study was undertaken to further investigate the effect of alcohol and glycerol and their possible interaction on the body, viscosity, hotness, taste and aroma of dry white table wine. This study was performed with three commercial Riesling wines, which had their ethanol and glycerol content increased by addition to three wine realistic levels (5.2, 7.2, 10.2 g/L glycerol and 11.7, 12.7 and 13.7% v/v ethanol). These additions had a small but inconsistent positive effect on the body and viscosity of the wines. The perceived hotness of the wines was strongly influenced by alcohol level, while sweetness, flavour and aroma intensity were relatively unaffected by either glycerol or alcohol. Assessors, given a broad definition of wine fullness, were idiosyncratic with regard to what features of the wine contributed to its fullness. However, flavour and perceived viscosity were most frequently and most strongly correlated with the fullness of these wines.

Defining, measuring and controlling important volatile aroma and flavour compounds in grapes and wine

Staff and students

Mark Sefton, Gordon Elsey, Alan Pollnitz, Dimi Capone, Kevin Pardon, Tracey Siebert, Katryna van Leeuwen (AWRI), Rachel Brown (Flinders University) Claudia Wood (Pontifica Universidad Catolica De Chile)

Collaborators

Philip Marriott (RMIT University)

Analytical methods for volatile wine components

Following the completion of our synthesis program for producing stable isotope-labelled analogues of several important thiols for use as internal standards in measuring these compounds in wine, we have now also synthesised both labelled and non-labelled conjugates of 4-mercapto-4-methylpentan-2-one (4-MMP) and 3-mercaptohexan-1-ol (3-MH) which are important grape-derived thiols in wine. These conjugates are thought to be the biogenetic precursors of the immediate precursors to these thiols. We are still investigating ways to separate the various isomers of the conjugates of 3-MH in order to determine whether one of these is more important than the other to grape composition.

Several additional deuterium-labelled standards required for developing new analytical methods for important volatile aroma and flavour compounds in grapes and wine have been synthesised. We have also been able to refine our current analytical method for 2-methoxy-3,5-dimethylpyrazine ('fungal must' cork taint) in wine and can now detect this taint with excellent sensitivity (sub nanogram per litre). Additional methods have been developed for important off-flavours in commercial wine samples (see below).

'Off'-odours in commercial wines

A number of commercial wine samples with a disinfectant/medicinal taint have been submitted recently to the AWRI for investigation. These wines were samples of many different red and white varieties, were submitted by several companies and were made across Australia. Initial analyses of these wines for chlorophenols, using methods available at the time, failed to find such compounds.

Extracts of several tainted wines were analysed by gas-chromotography/mass spectrometry (GC/MS), but no obvious cause of the taint could be seen. We then analysed organic solvent extracts of a sample of yeast hulls, which had imparted a disinfectant/medicinal taint to wine after several days contact with the wine. The compound 6-chloro-orthocresol was identified in the solvent extract of these yeast hulls. No other taint compound was detected in the extract, and no 6-chloro-orthocresol could be detected in another (non-tainting) batch of yeast hulls.

6-Chloro-orthocresol (6-CC) is one of the most potent chlorophenols known, and has been shown to be responsible for a similar type of taint in other food products. Informal sensory assessment by AWRI staff and also by several winemakers suggested that this substance could be detected in white wine by taste at a concentration of 10-15 ng/L. It therefore became necessary to develop a method that could detect 6-CC at a concentration down to, and below these levels, far below the detection limit for other chlorophenols in wine analysed by methods available at the AWRI at the time.

A sample of deuterium-labelled 6-CC was synthesised and used to quantify 6-CC in various wine samples down to 10 ng/L by GC/MS. We subsequently modified the method further, and are now able to quantify 6-CC down to 1 ng/L concentrations in wine. The method is currently available through the AWRI's Analytical Service. The modified method was used to reanalyse wines containing <10 ng/L 6-CC, and many of these contained low levels of this compound (0.5 to 9 ng/L). Further details of these results are given in the report by Industry Services Group.

From the analysis of wines for 6-CC, it became evident that some wines exhibiting a medicinal taint contained little or no 6-CC, and that it was likely that other compounds, derived from sources other than yeast hulls, were also contributing to, or were mainly responsible for, the perceived taint. Preliminary analysis of these wines for chlorophenols using methods available at that time had failed to show the presence of any of these compounds at, or above 1 µg/L, the analytical limit of detection. We therefore conducted a thorough investigation of one of these wines, that had only a small concentration of 6-CC, by gas chromatograph/mass spectrometry/olfactometry (GC/MS/O). Several unpleasant-smelling regions in the chromatograms of wines and wine extracts were noted. One of these regions corresponded with the retention time for 6-CC, while the remaining regions appeared to coincide with the retention times of authentic samples of various chlorophenols and bromophenols.

Because our experience with 6-CC had indicated that this compound could be detected in wine by sensory means at concentrations well below those indicated in the literature, we developed more sensitive analytical methods to measure other halophenols at similarly low concentrations. These also employed GC/MS and a range of ^{13}C-labelled standards prepared in-house. A preliminary investigation of one tainted wine showed the presence of 2,6-dichlorophenol at a concentration of 80 ng/L. An informal sensory assessment showed that a medicinal taint could be detected easily by aroma in a wine spiked with this concentration of 2,6-dichlorophenol.

The availability of these new analytical methods will enable us to determine whether halophenol taint in Australian wines is more widespread than previously recognised. The availability of accurate analytical data for halophenols at low concentration in wine is also likely to assist in pinpointing the cause of such taint. As is the case with 6-CC, it is important that the aroma and taste thresholds of these other halophenols in wine be determined in order to properly evaluate their relative impact on wine taint.

During the investigations described above, we also examined several wines, which exhibited a powerful and unpleasant plastic/chemical aroma. These wines were also analysed by GC/MS/O, which suggested that the cause of the unpleasant aroma was indole. An analytical method for determining indole in both red and white wines was developed and fully validated and applied to a range of 'sound' commercial wines and the three 'problem' wines. All of the wines contained indole, which appears to be a normal wine component, but the concentration in the sound wines was invariably low, while in the 'problem' wines, the concentrations were up to a hundred times greater. Indole off-flavour in other food products has been associated with bacterial metabolism.

Formation of damascenone in wine

Following completion of a long-term study into chemical mechanisms for the formation of damascenone in wine, we have conducted a trial in a commercial winery to determine ways of measuring damascenone potential in grapes that best reflect amounts formed during wine-making. The rate of formation of damascenone during vinification was, for the most part, consistant with rates of formation from synthetic precursors. However, it appears that, under some circumstances, substantial additional amounts of damascenone can be formed during ageing in barrel and that this formation could be via biological plus chemical mechanisms rather than chemical mechanisms alone. A program to synthesise several hypothetical biological precursors is well advanced, and once this phase is complete, we will be able to test this hypothesis.

Chiral aroma and flavour-impact compounds in wine

We recently completed a total synthesis of all four possible isomers of oak-lactone in high enantiomeric purity. Although only two of these are found in nature (they are extracted from oakwood during barrel maturation), all previous sensory investigations of these compounds in wine have been undertaken with mixtures of natural and non-natural isomers. For a panel of 28 (the same panelists were used for each determination), the nature-identical *cis*-isomer had an aroma detection threshold of 20 and 54 ppb in a white and red wine, respectively. The respective thresholds for the nature-identical *trans*-isomer were seven times greater – 140 and 370 ppb. For the corresponding non-natural counterparts, the thresholds were similar to, or greater than the values of the nature-identical *trans*-isomer and much greater than the *cis*-isomer, depending on the medium.

Compounds with similar aroma detection thresholds might still be distinguished from each other easily if their odour qualities differ. Therefore, difference tests were conducted on both pairs of enantiomers of the oak lactones, in order to establish if the panellists could distinguish between the individual enantiomers when tested directly against each other. For the *trans*-form, the difference between the natural and non natural isomers in either medium was not statistically significant, although a higher number of panelists picked the correct glass in each test, indicated that there might be a minority of panelists who were able to distinguish the two forms. For the *cis*-oak lactone, there was a clearer difference between the two isomers in both white and red wine. This could, however, simply reflect the different threshold data alone. Further sensory studies are required to determine whether the odour qualities also differ.

Finally, we wished to determine whether the presence of a significant amount of the natural isomer of *trans*-oak lactone in wine could modify the sensory impact of the natural *cis*-isomer. In wines matured in American oak barrels the proportion of the *trans*-isomer is generally small (10–15%) compared to the *cis*-isomer, but for French oak-matured wines these isomers are typically present in similar amounts. A difference test was conducted in which both red and white wines spiked with the natural *cis*-isomer alone were tested against the wines spiked with the same amount of the natural *cis*-isomer plus an equal amount of the natural *trans*. In neither medium was the difference between the wine with and without the *trans*-isomer statistically significant although, again, in both cases, a higher number of panelists picked the correct glass in each test.

Our data confirm the conclusion from earlier studies that the *cis*-isomer is likely to be more important to wine odour than is the *trans*-isomer. Indeed, it appears that, for a majority of the panellists used here, the presence of the *trans*-isomer at what would be relatively high concentrations for commercial wines is likely to have little or no influence on wine odour in oaked wines. This indicates that sensory differences between American and French oak-matured wines are more influenced by the absolute amounts of the *cis*-isomer (or of other compounds) than by the larger amounts of the *trans*-oak lactone in the latter (AWRI Publication # 883).

The relatively low detection threshold obtained by us for the nature-identical enantiomer of *cis*-oak lactone, compared to that obtained for the racemic form in previous investigations, indicates that the sensory impact of the natural compound in wine is likely to be even greater than previously assumed. Some panellists could easily detect the presence of *cis*-oak lactone in wine well below the group threshold concentration. A few, however, struggled to detect this compound at all, at concentrations typical of heavily oaked wines. Therefore, although a more detailed study is required to determine the natural variability in odour detection threshold among the general population, it should not be surprising, that consumers sometimes differ in their evaluation of the impact of oak on wine.

Wine quality and consumer preference: development of tools to understand market preferences and shifts

Staff

Leigh Francis, Kate Lattey, Belinda Bramley, Brooke Travis (since January 2006)

Consumer preference testing, when carried out in conjunction with trained sensory panel data, allows an accurate, fundamental insight into wine quality perceptions. A study has recently been completed to assess consumer preferences for a set of commercial Australian Cabernet Sauvignon and Shiraz wines with a wide range of sensory properties. The primary

aim of the study was to determine what sensory properties most influence consumer liking, with a secondary aim to assess whether Shiraz wines were generally more liked than Cabernet Sauvignon wines. Samples to be included were selected from a careful screening of around 100 potential candidates, to achieve a mix of wines that encompassed the range of styles available on the domestic market. Ten wines of each variety were studied, from the 2002 and 2003 vintages, including wines from across Australia from both niche producers and market leaders. All wines were priced between $10-34.

Sensory descriptive analysis was carried out using a trained AWRI panel to characterise and quantify the sensory attributes of the wines. Following this process, a subset of six wines of each variety were chosen for consumer testing, the 12 wines spanning the range of sensory attributes. Consumer testing was conducted in Sydney in early November 2005, where 203 consumers who regularly drink Cabernet Sauvignon and/or Shiraz rated their overall liking for each of the 12 wines over two sessions. Approximately equal numbers of males and females took part, with an equal proportion of consumers recruited aged between 18-35 and 36-65.

Ten of the wines were also assessed for overall quality, according to the Australian Wine Show scoring system, by the 60 participants, predominantly experienced winemakers, of the two AWRI Advanced Wine Assessment Courses held in September and October 2005.

Extensive chemical analysis on the wines was also carried out by members of the AWRI flavour, tannin and rapid instrumental research teams in order to determine relationships between sensory properties and composition of the wines.

The wine that was liked most by the 203 consumers as a group had the highest rating (from the trained sensory panel data) for sweetness and was also rated high in fruit flavour intensity. Several wines with moderate levels of fruit flavour and a relatively low degree of astringency were also highly liked overall. Wines with strong 'Brett' related flavour attributes were among the least liked overall, with a Shiraz wine exhibiting a black pepper and vegetal flavour profile was the least liked. Wines with relatively high levels of acid and/or bitterness were generally not liked by consumers, and there was no difference in overall liking between the Shiraz wines as a group compared to the Cabernet Sauvignon wines.

For this type of study, overall liking scores averaged over the entire set of consumers, while of great interest, provide only a limited insight into consumer behaviour. Upon looking more closely at individual responses, there were found to be large differences in liking scores within the set, and five distinct groups of consumers were identified, with consumers in each group having similar preference patterns.

Interestingly, different sensory attributes were found to be driving the preferences for each group. For example, responses across the groups were mixed for wines with 'fresh green' flavour, with one cluster comprising 19% of the total group preferring the wines – all examples of Cabernet Sauvignon – that exhibited this character. This cluster had a greater proportion of consumers aged less than 35.

While little relationship was seen between consumer demographics and their liking responses, a trend was observed that younger consumers liked the wines less overall and also had a wider range of scores, with stronger likes and dislikes compared to the older people.

As found in previous studies, there was no relationship between the expert wine assessors' quality scores and the consumers' liking scores, with the exception of the wines affected by *Brettanomyces* which were rated low by both groups. Wines that were scored highest in quality by the Advanced Wine Assessment Course (AWAC) participants were rated by the trained panel as highest in the astringency terms, 'hotness' and relatively high in 'fruit flavour intensity'. As observed with the consumer panel, there was a wide divergence of quality score behaviours among the expert panel, with limited correlation between individual judge's scores.

This study gave a wealth of information about wine sensory properties that are most important to both consumers' and wine judges' ideal of quality, and provided highly valuable knowledge regarding what proportion of the population likes wines of differing styles. Using the combination of data from a trained sensory panel, consumer liking response and winemaker scores, valuable insight into perceptions of wine quality was gained. The results of this study will allow the Australian wine industry to better tailor the production of distinctive wines which appeal strongly to specific groups of consumers, as well as wines that are acceptable to a large proportion of the Australian wine drinking population. Clearly, such consumer preference studies will be of importance for our increasingly consumer-driven industry to ensure we remain globally competitive.

Sensory analysis at the AWRI

Sensory evaluation activities at the AWRI are run by the specialist Sensory Team working with our highly experienced panellists. Apart from the Wine Quality and Consumer Preference research project, the sensory team conducts sensory components of AWRI research projects with our colleagues in other research groups. Numerous sensory projects are also run with the Industry Development and Support and Analytical Service sections of the AWRI for external wine industry clients.

Over the last twelve months there have been 47 individual tasting sessions of between three and seven samples assessed by our technical panel for the presence of taints or faults often as part of an investigation of the chemical identity of possible off-flavours by the Industry Development and Support Group. Thirty-five sets of bottled wine (from six to 48 individual bottles) have been assessed over the year for the incidence of taints or faults. Difference tests have also been commonly carried out: 62 triangle and duo-trio test comparisons in total, apart from training and panel performance sessions. Contract research projects, also through Analytical Service, have had a considerable sensory component, notably the large commercial closure trial assessing a range of closures for different suppliers or manufacturers, at 36 months post-bottling, and also smaller-scale shelf-life studies involving other packaging materials.

A major AWRI-wide investigation on a chlorophenol-like taint led by Industry Services staff has involved numerous sensory investigations. Initially, this investigation involved sessions to screen and train assessors from the technical panel pool, to find those tasters most sensitive to the taint, followed by rating sessions to determine those wines affected by the taint, and finally a large series of triangle test determinations to assess the aroma and taste thresholds of many chlorophenol and bromophenol compounds.

Major sensory studies have been completed as part of the research programs, reported elsewhere, and have included studies with the research teams of 'Interactions of non-volatile and volatile compounds in wine' (effect of ethanol and glycerol on white wine body), Biosciences (yeast strain effect on Sauvignon Blanc aroma) and Tannin (Leasingham Clare trial with a panel of Hardy's winemakers).

A large collaborative sensory descriptive analysis study was carried out with John Considine of University of Western Australia and Evans and Tate wines for the Margaret River Chardonnay project, with duplicate wines made from grapes sampled from 22 different Margaret River sites assessed in duplicate by a panel at the AWRI. The study showed that there were significant sensory differences among the vineyards and the sensory data will be related to the numerous viticultural data obtained from the project.

The Sensory Team, in conjunction with Hentie Swiegers and Robyn Willmot from the Biosciences team, was involved in running several tasting sessions with winemakers who participated in the Sauvignon Blanc yeast strain project (see Biosciences Report for more details). Preference data were obtained for the research-scale wines and all the commercial wines.

As in previous years, numerous on-going panel training and performance assessments have occurred on a continuous basis. The Sensory Team was also heavily involved in running two four-day Advanced Wine Assessment Courses in 2005. Brooke Travis joined the Sensory Team in January 2006, providing greater capacity and expertise to meet the range of often pressing demands for reliable sensory analysis data across AWRI activities.

Team reports

Identification, measurement and enhanced control of non-volatile phenolic compounds responsible for colour and mouth-feel of wine

Staff and students
Markus Herderich, Paul Smith, Helen Holt, David Jeffery, Mango Parker, Meagan Mercurio (AWRI), Maria Birse (University of Adelaide), Eric Dennis (Flinders University).

Collaborators
Chris Ford, Sue Bastian, Caroline Payne, Vlad Jiranek, Tristan Warren (School of Agriculture and Wine, The University of Adelaide), Michael Perkins (School of Chemistry, Physics and Earth Sciences, Flinders University), Simon Robinson (CSIRO Plan Industry), Amy Richards, Michael McCarthy (SARDI), Patrick Iland (Patrick Iland Wine Promotions), Chris Bevin (Hardy Wine Company), Kerri Thompson, Warren Birchmore (Leasingham Wines), Bruce Kambouris (McGuigan Simeon Wines), Sue Hodder (Wynns).

The 'Tannin project' has the long-term objective of evaluating the role of phenolic compounds present in red grapes and wine in colour, astringency, mouth-feel and taste. A wide range of techniques have been investigated and methods for measurement, structural characterisation and sensory evaluation of phenolic compounds, including anthocyanins, grape tannins, wine tannins and pigmented polymers have been established. Viticultural and winemaking experiments have enabled us to better understand some of the influences on formation and extraction of grape phenolics, and how they are modified or degraded in wine. The Tannin Team collaborates extensively within the AWRI and externally with organisations such as University of Adelaide, Flinders University, CSIRO and SARDI.

Analysis of phenolic compounds
To drive the development, adoption and application of new, industry applicable methods for tannin measurement, Meagan Mercurio joined the team in August 2005. In response to the wine industry's need for objective indicators of grape and wine quality, a practical standardised methodology for quantifying tannins in grape and wine samples has been developed (AWRI publications #894, #922). This tool for grape and wine tannin analysis by precipitation with methyl cellulose is now fully optimised, validated and available to industry and researchers alike in 1 mL, 10 mL and high throughput formats. A standard operating protocol, which can be obtained on request, has been developed and the assay (designated MCP tannin assay) is commercially available through the AWRI Analytical Service. The assessment of the role of colour as a quality indicator has also been aided by development of a complementary, plate-reader compatible format of the Somers colour measurement, which enables significantly higher throughput analysis of red wine colour attributes. Paul Smith continues to focus on the potential for tannin as a quality indicator, and a survey of Australian grape and wine tannin concentrations and their relationships with quality is ongoing. With the help of the survey data we are beginning to gain the first insights into the range and variability of tannin concentration by variety and region.

Collaboration continued with the AWRI Sensory Team, and their assessment of twenty commercial Australian red wines allowed us to show there was a strong correlation (r^2=0.85) between total tannin concentration determined by the MCP tannin assay and 'drying' as rated by a descriptive analysis panel, indicating that the tannin assay may mimic some mechanisms involved with human perception of astringency.

Method development and optimisation for measurement of white grape and wine phenolics has been initiated. Mango Parker is 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. It is planned for this work to have a strong collaborative focus through interaction with research groups at AWRI and The University of Adelaide and industry partners.

Finally, the identity of four flavonols commonly found in red wine, including quercetin, has been established using high-performance-liquid-chromotography/electron spray ionisation/mass spectrometry (HPLC-ESI-MS) analysis, which allows us to include these compounds with our routine analysis for phenolic profiling. These flavonols are important sun exposure markers in some grape varieties and can contribute to the formation of precipitates and bottle deposits.

Isolation and characterisation of grape and wine tannins
One of the last frontiers in natural product chemistry is the characterisation of structure, reactivity and function in tannins. As phenolic compounds in wine constitute a hugely heterogenic mixture and reference substances are largely unavailable from commercial sources, separation, isolation and characterisation of pure compounds are a significant challenge. Progress in characterisation of red wine tannins requires new technologies for separating this complex class. David Jeffery has progressed research in this area with the assessment of several new analytical HPLC techniques, such as size exclusion chromatography. In addition, an electrochemical detector capable of assessing the redox properties of polyphenols has been commissioned and may help understand unusual behaviour of wine tannins and pigmented polymers, which is possibly related to oxidation status or other ageing reactions. Taking advantage of novel solid phase resins, a method has also been developed in our laboratory for rapidly isolating pure wine tannins with minimal handling and aids our method development capacities by giving access to the most diverse and relevant material possible.

The successful collaboration with Michael Perkin's Natural Products Chemistry research group at Flinders University has continued with the PhD research of Eric Dennis on the organic synthesis of condensed tannins. Good progress was made in interconverting functional groups of the monomeric tannin building blocks catechin and epicatechin in order to modulate their reactions with each other. The coupling of these monomeric units together into larger, structurally-defined tannin polymers remains the focal point of this research project.

Identification of red wine pigments
In collaboration with Vlad Jiranek and Tristan Warren (University of Adelaide) we are studying the effects of wine yeast on colour extraction and stabilisation in red wine. This research investigates the role of yeast in the liberation of anthocyanins from grape skins by hydrolytic enzymes, degradation of anthocyanins, formation of metabolites which favour pigmented polymer formation and loss of pigments through binding to yeast lees.

Effects of viticultural treatments and winemaking practices on red wine colour and tannin levels
Final assessment of the compositional and colour analysis of a winemaking trial that was performed in 2003 with pre- and post-fermentation additions of 200 mg/L of a commercial grape-derived tannin product has concluded. [P. Smith and M. Herderich 'The effects on red wine of pre- and post-ferment additions of grape-derived tannin' *Technical Review* (152): 3-10; 2004] After storage for 22 months, the data from the red wines confirmed the initial finding that that no significant colour differences could be observed, though a significant difference in astringency was perceived in wines following the tannin addition.

In our applied research into structure-function relationships of phenolic compounds, Helen Holt aims to improve understanding of the relationships between viticultural practices, grape composition and red wine composition and sensory properties. The main result from a viticultural trial using Clare Valley Cabernet Sauvignon to study the effects of berry size on grape and wine phenolics and wine sensory properties is that vines from all pruning treatments provided grapes of high colour (more than 1.5 mg/g). Compared to spur, and rod-and-spur pruned grapevines, machine pruning consistently resulted in grapes with the highest colour in all vintages and all maturity levels in this trial. However, wines produced from the machine-pruned vines were consistently identified as the less preferred wines in sensory analysis by winemakers. This supports the hypothesis that at high grape colour values, grape colour, when looked at in isolation, is not necessarily a suitable marker to differentiate between grape or wine quality of premium grapes. In-depth data analysis has highlighted effects of grape maturity and irrigation and seasonal effects on grape and wine composition, and on wine style, and the results of these studies are currently being drafted for publication. As

the application of mini-lot fermentations was essential for this study, our protocols and experiences with such experimental wine-making practices have been summarised with a technical publication (H. Holt, P. Iland, R. Ristic. 'A method for mini-lot fermentation for use in research and commercial viticultural and winemaking trials' Australian and New Zealand Grapegrower and Winemaker 509a; 74-81, 2006).

Improving microbial performance, wine diversity and wine quality

Staff and students

Eveline Bartowsky, Jenny Bellon, Anthony Borneman, Paul Chambers, Chris Curtin, Angus Forgan, Paul Henschke, Jane McCarthy, Sakkie Pretorius, Simon Schmidt, Hentie Swiegers, Maurizio Ugliano, Cristian Varela, Robyn Willmott (AWRI), Ellie King (University of Adelaide), Dariusz Kutyna and Tina Tran (Victoria University)

Visiting scientists and students

Ana María Molina (Pontificia Universidad Catolica de Chile) and Inmaculada Blazquez Rojas (Universidad de Castilla-La Mancha, Spain).

Collaborators

Eduardo Agosin (Pontificia Universidad Catolica de Chile), Peter Anderson (Flinders University), Sylvie Callegari (University of South Australia), Francisco Carrau (Universidad del la Republica, Uruguay), Miguel de Barros Lopes (University of South Australia), Graham Fleet (University of New South Wales), Vladimir Jiranek (University of Adelaide), Mariska Lilly (Stellenbosch University, South Africa), Brian O'Neill (University of Adelaide), Grant Stanley (Victoria University, Melbourne), Pierre van Rensburg (Stellenbosch University, South Africa), Charles Boone (University of Toronto), Barbara Dunn (Stanford University, USA).

The current general research interests of the Biosciences Team at AWRI include: the generation of yeasts and bacteria that confer improved wine sensory properties; improved stress tolerance of wine yeasts and MLF bacteria; production of new wine yeasts using non-GM approaches, such as interspecies hybridisations; development of 'low alcohol' yeasts and development and commercialisation of wine microorganisms.

Flavour-enhancing yeast: thiols and esters

We are studying aroma and flavour compounds that are produced or transformed by yeast during wine fermentation. We focus on understanding the metabolic pathways and genes in yeast that are involved in flavour production, and applying knowledge from this to metabolic engineering for research purposes and winery applications.

We have conducted trials in which a range of commercial wine yeasts were compared for their capacities to impart flavour attributes to Sauvignon Blanc. Analytical and sensory results indicated that the choice of wine yeast strain used in a ferment can have a significant impact on the aroma profile of wines (AWRI publication #917). We are particularly interested in the potent and fruity volatile thiols, including 4-mercapto-4-methylpentan-2-one (4MMP), 3-mercaptohexanol (3MH) and 3-mercaptohexyl acetate (3MHA). During the last year, we conducted small-scale (20 L) ferments on Adelaide Hills Sauvignon Blanc and results indicated that commercial yeast strains differ largely in their abilities to (i) release 4MMP and 3MH from their flavourless, cysteine-bound precursors produced by the grape; and (ii) convert 3MH to 3MHA. Chemical analysis of fermentation products also indicated large differences in flavour profiles for wines produced by different wine yeasts; in particular, ethyl acetate (fruity, estery), isoamyl acetate (banana), 2-phenylethtyl acetate (floral) levels varied considerably for the range of yeasts trialed. Importantly, results from sensory analysis correlated with chemical analysis, with the wine yeast strain producing the highest concentration of volatile thiols having the highest passion-fruit rating and the wine yeast strain producing the highest ester concentrations having the highest estery/confectionary aroma. Furthermore, the choice of yeast strain affected winemakers' preferences for the wines. As a continuation of this work we initiated Sauvignon Blanc co-inoculation yeast trials this year with the aim of modulating volatile thiol and other aroma components through yeast-yeast interactions.

Work on the characterisation of genes encoding flavour-enhancing enzymes involved overex-pression of a carbon-sulfur lyase gene in a yeast, and this resulted in a significant increase in volatile thiol release and subsequent passion-fruit aroma.

We are also investigating the expression of key volatile thiol and ester modulating genes, including *ATF1* and *IAH*. Work to-date indicates that different wine yeast strains vary in their levels of expression of these genes and this has been correlated with the aroma compounds

produced. Preliminary results indicate that expression varies throughout the ferment and is affected by temperature. This work is conducted in collaboration with Anita Molina (visiting PhD student) and Eduardo Agosin (Pontificia Universidad Catolica de Chile).

Mechanisms of glycoside release during yeast fermentation

The so-called 'floral' grape varieties, which include Muscat, Gordo, Frontignac, Riesling and Gerwürtztraminer, contain in the grape berry a pool of free flavour compounds, mainly monoterpene alcohols, which elicit a characteristic floral aroma, when compared with non-floral varieties, as exemplified by Chardonnay and Semillon. In addition, both floral and non-floral varieties contain a relatively high concentration of precursors of these flavour compounds, which are non-volatile and, hence, odourless. These compounds are present largely as glycoconjugates, monoglucosides, disaccharides and trisaccharides. Commercial enzyme preparations with glycosidic activities can be used to release the volatile flavour compounds by hydrolysis of the glycosidic linkages. However, the observation that wines produced from non-floral varieties exhibits sensory attributes that are linked to glycoside-related volatiles suggests that fermentation may lead to an enhancement of the varietal character of wines through the hydrolysis of grape glycosidic precursors. A better understanding of the mechanisms involved in the enhancement of grape varietal character during fermentation will allow selection and development of yeast for use with grapes in which the concentration of flavour precursor compounds is suboptimal.

To investigate the apparent mechanism(s) of release of terpenoid compounds in fermentation, a glycoconjugate fraction was extracted from a floral grape must and introduced into a chemically defined grape juice-like medium. One portion of the medium served as control without yeast while the other portion was subjected to fermentation with either *S. cerevisiae* or *S. bayanus* yeast strains. The samples were then analysed for free terpenoids. The yeast-free samples enabled us to estimate the proportion of glycoconjugates that were hydrolysed by the mild acidic conditions of the medium, pH 3.5, which is similar to that of fermentation. Depending on the terpenoid glycoconjugate, a range of 10 to 70% of the total terpene release was found due to yeast activity.

Characterisation of the glycosidic activities of yeast was made by the use of synthetic glycosidic compounds. This study showed that the main activities necessary for the hydrolysis of grape glycosides, β-glucosidase, α-L-arabinofuranosidase and α-L-rhamnopyranosidase, were eleborated by the yeast strains studied. We can conclude that these enzymes contributed to the hydrolysis of the terpenoid glycoconjugates in fermentation.

All of the important terpene alcohols were detected in the wines following fermentation. However, as previously reported the concentration of geraniol was lower than expected when a comparison of its concentration was made between the yeast-free and fermentation samples. It was also noted that the yeast-free samples were devoid of the monoterpene alcohol, citronellol, whereas the fermentation samples contained significant concentrations of this compound. This occurrence can be rationalised according to recent *in vitro* experiments carried out in other laboratories which have demonstrated the transformation of geraniol to citronellol by yeast. Thus, we can conclude that yeast not only have the capability to release terpenoid compounds from their glycoconjugates but can also transform them to new compounds. In this case, citronellol has a more citrus-like aroma than geraniol, and consequently yeast with different abilities to perform this transformation might affect the aroma profile of wine.

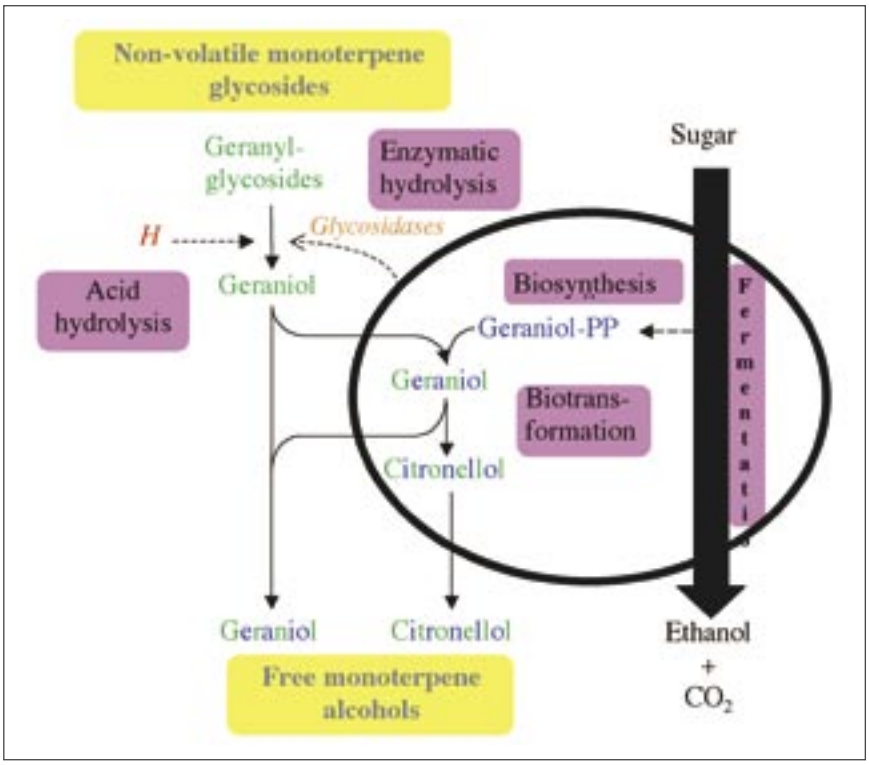


Figure 2. Summary of mechanisms for the production of volatile flavour compounds from grape precursor compounds.

The glycoconjugates that survived hydrolytic and enzymatic hydrolysis during fermentation were subjected to further chemical analysis to establish whether the types of terpenoid compounds and sugar(s) attached affected the stability of the conjugate to enzymatic and acidic hydrolysis. To do this, the residual glycosides were subjected to derivatisation with N-methylbis(trifluoroacetamide) and analysed by GC-MS analysis. This analysis revealed that both the structure of the terpenene and sugar moieties affected the extent of hydrolysis of the grape glycocongated flavour precursors during fermentation. Thus, some flavour precursors are hydrolysed to a greater extent than others, and depending on their aroma value, can contribute more or less to the wine's aroma profile. Aspects of these investigations were recently published (AWRI publication #915).

In addition, the results of a collaborative study with Francisco Carrau and colleagues at the National University, Montevideo, Uruguay have shown that with certain strains used under certain fermentation conditions the important monoterpene alcohols can be synthesised from products of sugar metabolism in fermenting yeast. Therefore, the potential exists for yeast to produced terpenoids not only from grape glycosides but also from grape sugar. This pathway might be of particular interest in varieties low in glycosylated monoterpenes (AWRI publication #836).

The various mechanisms by which yeast can hydrolyse, synthesise and transform terpenoid compounds are summarised in Figure 2. Our results combined with those of other laboratories show that the accumulation of the floral terpenoids during fermentation is a complex phenomenon, which depends on the concentrations of the grape glycosidic precursor compounds and the types of compounds present, the strain of yeast selected for fermentation, and the fermentation conditions. These investigations also confirm the important role of yeast in the expression of grape varietal character and point to research targets for selecting and genetically improving strains of yeast to enhance varietal character in wines made from grapes with low free or precursor levels.

The formation of the floral aromatic monoterpene alcohols is used as an example. Monoterpene glycosides (green), in this case geraniol glycoside, present in grape musts of certain varieties, can be hydrolysed by yeast glycosidic enzymes to release the free (volatile) monoterpene alcohol (geraniol). Acid-catalysed hydrolysis of the glycoside can also lead to free geraniol, although this mechanism was found

to play a less important role compared to yeast-driven hydrolysis. A portion of the geraniol released by either mechanism can enter yeast metabolism and become transformed to citronellol and other monoterpene alcohols, which can be excreted by yeast (green-blue). Monoterpene alcohols can also be synthesised from sugar and be excreted by yeast (blue). Some of the synthesised geraniol can also be transformed to citronellol, and other monoterpene alcohols and be excreted by yeast (green-blue).

Flavour-active bacteria

The main objectives of this program are to understand and improve the induction of malolactic fermentation (MLF) and the modifications that MLF make to wine aroma and flavour. Bacterial metabolism of grape and wine components during MLF not only decreases wine acidity but also modifies the aroma and palate of red and white wines. For example, previous research in our laboratory has demonstrated that when a post-MLF red wine is adjusted to pre-MLF pH and titratable acidity values, significant aroma and palate descriptors remain detectable that can be attributed to bacterial metabolism of grape and wine components.

Grape glycosides represent a pool of non-volatile 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. Previous work has demonstrated the ability of several strains of *Oenococcus oeni* to release a group of volatile compounds from glycosides in Chardonnay grape juice (AWRI publications #762 and #770).

A better understanding of the variation in glycosidase activities in *O. oeni* and other LAB species has recently been undertaken by Antonio Grimaldi, a University of Adelaide PhD student co-supervised by Dr Vladimir Jiranek (University of Adelaide) and Dr Eveline Bartowsky. Numerous *O. oeni* strains were examined for α-D- and β-D-glucosidase, α-L-rhamnosidase, α-L-arabinosidase and β-D-xylopyranosidase activities at various pH, ethanol and sugar (glucose + fructose) concentrations, and temperatures. Several strains exhibited high α-D- and β-D-glucosidase activity while others exhibited good α-L-rhamnosidase, α-L-arabinosidase and β-D-xylopyranosidase activities. Some strains were able to retain significant glycosidase activity at typical wine pH (~ 3.0 - 4.0), residual glucose and fructose contents (up to 20 g/L), and with ethanol content up to 12% (AWRI publication #872). This study was extended to species of the *Lactobacillus* and *Pediococcus* genera. These were found to have varying degrees of α-D- and β-D-glucosidase activities that were influenced differently by exposure to ethanol and/or sugars, temperature and pH (AWRI publication #869). These studies highlight that strains of LAB show promise in their ability to hydrolyse glycosides under wine conditions and thereby potentially influence the flavour and aroma of wine.

The timing of MLF induction relative to alcoholic fermentation can also impact on wine sensory characteristics. Preliminary research from our laboratory has highlighted the potential of varying MLF inoculation regimes to modulate sensorially important chemical components. A small-scale (3 L) trial demonstrated that inoculation regime and duration of MLF were important contributors to changes in the fermentation product profile. This is consistent with observations on manipulating diacetyl content in wine by altering the duration of MLF, where slower MLFs tend to result in higher diacetyl concentrations (AWRI publication #795).

Low-ethanol yeasts

Wines made from grapes grown in warm, sunny climates are typically rich and full-bodied, with exotic flavour profiles. At the same time warm climates also provide grapevines with ideal conditions for sugar production, leading to grapes, and subsequently grape juice with high Baumé. This, in turn, translates to high levels of alcohol in wine. High alcohol content is not necessarily a bad attribute but it can compromise the flavour of a wine, lead to increased costs in the form of higher taxes (which, in many countries, are levied according to ethanol content), and there are health concerns associated with excessive ethanol consumption. This has led to a push to develop strategies for reducing the ethanol content of wine, without compromising sensory properties.

Scientists at the AWRI and in other laboratories around the world have been successful in using gene technologies to create yeasts that are able to partially divert sugar metabolism away from ethanol production to other end points such as glycerol. This has led to the generation of yeasts that make less ethanol than the parent strains they are derived from. Our aim is to employ a combination of tried-and-tested strategies to develop a low-ethanol wine yeast. If successful, such GM yeasts would provide important tools to improve our knowledge about what is possible with respect to reducing ethanol production in wine yeasts, and will help us to develop improved strategies for generating suitable wine yeasts using traditional, non-GM approaches. One of the strategies we are employing involves engineering the *GOX* gene from *Aspergillus niger* into a wine yeast. This gene encodes glucose oxidase, an enzyme that converts glucose into the non-fermentable gluconic acid. The presence and expression of the GOX gene in a wine yeast will enable the 'removal' of sugars from ferments before they can be converted into ethanol. In the same yeast we are also over-expressing the native glyceraldehyde-3-phosphate dehydrogenase (GPD) genes. This has been shown to lead to the partial diversion of sugar metabolism away from ethanol to glycerol production. Applying both of the above strategies to the same yeast will generate a wine yeast that makes considerably less ethanol than the parent strain it was derived from. This work is being done in collaboration with Daniel Malherbe, a PhD student from Stellenbosch University (South Africa).

A more challenging part of this project is to make 'low-alcohol yeasts' using traditional, non-GM approaches that are acceptable to consumers; yeast generated by these approaches can be used immediately by the wine industry. The approach we are trialling is known as adaptive evolution and is based on Darwinian natural selection; we are applying selection pressures to wine yeasts that favour the growth and reproduction of variants that make less ethanol than their parent strain. However, finding a selective pressure that favours 'low-ethanol yeasts' has not been straightforward. We are currently using a strategy that is delivering promising results, but this work is still at the early stages of development and the differences in ethanol production we are seeing are still rather small. This part of the project is being done in collaboration with Associate Professor Grant Stanley (Victoria University, Melbourne), and Dariusz Kutyna, a PhD student from the same university.

Stress-tolerant wine yeasts

Stress-tolerance in wine yeast *(Saccharomyces cerevisiae)* is of importance to the wine industry because stress has been identified anecdotally and in the scientific literature as a contributor to stuck and sluggish fermentations, leading

to incomplete utilisation of sugars in grape juice. Although wine yeasts have a relatively high level of stress-tolerance compared to other yeasts, some wine yeast strains are more tolerant than others. This tells us that there is a genetic component to stress resilience, although most of the genes involved have yet to be defined.

We are currently taking two approaches to improve our understanding of yeast tolerance to stress, focusing particularly on ethanol stress. One of these approaches is being done in collaboration with Grant Stanley (Victoria University, Melbourne) and Miguel de Barros Lopes (University of South Australia, Adelaide) and is being carried out by a PhD student with a scholarship from Victoria University, Tina Tran. Tina is attempting to identify and characterise genes that confer improved ethanol tolerance on spontaneous and chemically induced mutants of a laboratory *S. cerevisiae* strain that were derived using adaptive evolution.

In parallel with this we are using the same approach to raise wine yeast strains with increased ethanol tolerance. Such strains will be of direct benefit to the industry and will provide a means of further increasing our understanding of ethanol-tolerance. We have analysed 21 industrial wine yeast strains for stress-tolerance and observed considerable variation in the responses of different strains to ethanol challenge. Using a subset of these strains in a more detailed evaluation we found a good correlation between industrial performance (i.e. time to dryness in large-scale ferments) and measures of ethanol tolerance as determined in the laboratory. These findings reinforce previous reports about the importance of ethanol tolerance as a factor in strain reliability and fermentation vigor.

We are investigating a number approaches for yeast strain development with the aim of generating strains with increased stress-tolerance. At this time, continuous adaptive evolutionary cultures have been growing for over 500 generations (5 months) under increasing ethanol stress. Such a system has been shown to allow selection of stress tolerant laboratory strains of yeast but is novel in its application to industrial strains. In combination with other selection methods we are defining strategies that will be routinely incorporated into strain development programs so as to maximise the performance of existing and novel yeast strains. This will bring benefits to industry not only by extending the range of yeasts available to winemakers but also by providing information that will enable winemakers to make more informed decisions when purchasing yeasts.

Interspecific hybrid *Saccharomyces* yeasts

This project aims to produce yeast with novel wine flavour profiles by the hybridisation of non-*cerevisiae* species of *Saccharomyces* with tried and tested strains of *Saccharomyces cerevisiae*. In brief, various *Saccharomyces* species were selected as hybridisation partners to mate with *cerevisiae*; few of these non-*cerevisiae* strains are capable of completing unassisted alcoholic fermentation of grape juice.

Four hybrid yeasts have been produced which are genetically stable and capable of fermenting grape juice. The hybrids include *S. paradoxus-S. cerevisiae* (AWRI 1501), *S. cariocanus-S. cerevisiae* (AWRI 1502), *S. kudriavzevii-S. cerevisiae* (AWRI 1503) and *S. mikatae-S. cerevisiae* (AWRI 1504). Two strains, AWRI 1501 and AWRI 1503 were chosen for industry trials because of interesting wine sensory properties.

AWRI 1501 *Saccharomyces cerevisiae x Saccharomyces paradoxus* hybrid *Saccharomyces paradoxus* is sometimes found in grape must, though not yet reported in Australian musts, but having low vigour, it generally fails to complete fermentation. However, the hybrid yeast has medium to high vigour fermentation properties similar to *S. cerevisiae* AWRI 838, and produces low residual sugar in Chardonnay. Basic wine chemical parameters are also similar to those of *S. cerevisiae* AWRI 838. The aroma profile was described as low in *ester* with *nuts* and *figs*, based on a barrel fermented Chardonnay trial. This hybrid yeast appears to be well suited for building flavour complexity.

AWRI 1503 *Saccharomyces cerevisiae x Saccharomyces kudriavzevii* hybrid *Saccharomyces kudriavzevii* is not capable of fermenting grape juice, however the hybrid yeast has medium to high vigour fermentation properties similar to *S. cerevisiae* AWRI 838, and produces low residual sugar in Chardonnay. Basic wine chemical parameters are similar to those of *S. cerevisiae* AWRI 838. In a barrel fermented Chardonnay trial (2004), the aroma was described as *estery, floral, tropical, citrus, nutty* and *waxy,* and the palate showed a creamy texture with complex acid, with a late mineral character. This hybrid yeast appears to be well suited for building aroma and palate complexity.

Nutrient management of fermentation and implications for wine flavour

Yeasts have an absolute requirement for nitrogen which is needed for growth and maintenance of adequate fermentation rate. The amino acids and ammonium constitute the important nitrogen sources in grape must, however, it is now well established that the levels of these compounds are often suboptimum. Such occurrence increases the risk of sulfide formation and stuck fermentation. We have recently shown that the profile of aroma compounds of Chardonnay wine is also highly dependent on grape must yeast assimilable nitrogen (YAN) concentration (AWRI publication #875). Furthermore, we have shown that the sensory profile of Chardonnay wine is highly dependent on must nitrogen content. Thus, superoptimal as well as suboptimal nitrogen concentrations can negatively impact on wine quality.

Nitrogen deficiency and various fermentation problems are corrected in the winery typically by adding DAP in the form of diammonium phosphate (DAP) or proprietary products which contain nitrogen. Our precursor studies which address the flavour impact of nitrogen management in fermentation have, however, raised several important questions, such as does the metabolite profile produced by all yeast strains respond to grape must nitrogen in a similar manner, is the type of nitrogen source important, when should it be added to the fermentation and does the optimum concentration of grape must nitrogen vary for different wine types?

To answer some of these questions we are pursuing several lines of investigation. Firstly, series of experiments to establish whether the optimum level of nitrogen varies with different yeast strains have been conducted by Mar Vilanova, a visiting scientist from Consejo Superior de Investigaciones Cientificas, Spain. Secondly, Maurizio Ugliano from University of Foggia, Italy, has recently taken up a postdoctoral position to investigate the role of grape must nitrogen in the regulation of fermentation products by yeast during fermentation. During vintage 2006 he initiated a study of the impact of DAP addition on the chemical composition and sensory attributes of Shiraz wine.

In order to build on our preliminary studies aimed at understanding the effects of nitrogen on yeast metabolite formation Mar Vilanova has carried out DAP supplemented fermentations of Albariño using a high nitrogen demanding yeast. Albariño is an important aromatic variety grown in Galicia, a relatively cool region in the north-west of Spain. The results of this study showed that significant differences were found amongst the different wines in terms of the concentrations of most aromatic compounds typically produced by *Saccharomyces* yeast. This is despite the fact that the lowest concentration of grape must nitrogen studied (250 mg YAN/L) is considered to be at a moderate level for Australian musts. The initial nitrogen content of Albariño musts affected fermentation duration, wine composition and yeast volatiles content. In this study, ethyl esters and higher alcohols were the most affected compounds. This trial, which also used a high nitrogen demanding yeast, but a different strain from that used in our Chardonnay study, confirmed the impact that nitrogen availability has on the formation of yeast fermentation products that are known to influence wine flavour.

In order to gain comparative information on the response of the two high-nitrogen demanding yeasts used in the vinification studies with Chardonnay and Albariño, we performed controlled experiments with chemically-defined media, which resemble the nutrient content of grape must. The initial nitrogen content of the various fermentations varied five-fold from approx. 100 mg YAN/L. As expected the biomass yield and duration of fermentation depended on initial must nitrogen concentration and residual sugar concentration was inversely related to initial nitrogen content. All assimilable nitrogen was consumed within several days of fermentation commencing except when the initial concentration exceeded 400 mg YAN/L. Ethanol yield showed a small inverse trend, although this was not significant. Glycerol showed a similar but significant trend to ethanol. As observed in wines prepared from grape musts, most of

the yeast fermentation products varied with initial nitrogen content of the media; however, the two yeast strains showed different metabolite response patterns. In particular acetic acid and ethyl acetate patterns depended strongly on both nitrogen and yeast strain, and interactive effects between these were also observed. Individual esters, higher alcohols and fatty acids showed complex patterns with respect to initial nitrogen concentration and yeast strain but in general these data suggest that intermediate concentrations of must nitrogen favour a good balance of esters, higher alcohols and fatty acids.

Work is currently in progress to determine the effect of initial nitrogen concentration on the chemical composition and sensory profile of Shiraz. Preliminary results are showing that nitrogen affects the duration of fermentation and the apparent aroma profile of young wine immediately post-fermentation, and chemical and sensory analysis are being undertaken to quantify the effects of nitrogen.

The AWRI Culture Collection

Staff

Eveline Bartowsky and Jane McCarthy

The AWRI bacteria and yeast culture collection currently contains over 1800 strains (450 bacteria and 1370 yeast). These microorganisms include reference strains, winery isolates, research and experimental strains. This microorganism collection is an important and valuable resource for the AWRI and the Australian wine industry. Wineries can deposit their cultures in the AWRI culture collection and request slopes at any time. We are currently incorporating the latest molecular biology-based techniques to confirm identity of strains at the genus and species level, and to distinguish strains within a species. This is an on-going process, which will be continually expanded and improved.

Included in the culture collection are yeast strains available to the Australian wine industry including commercial strains and experimental strains which have been developed at the AWRI. Information received from wineries on commercial scale fermentations with the experimental yeast strains augments the AWRI knowledge-base and helps to develop a detailed overview on performance and potential of these yeast strains. Continued interest has been shown in the experimental yeast strains with numerous Australian wineries using them in their winemaking regimes.

Requests for microorganisms are received from Australian wineries, research institutes (world wide), Australian teaching institutions and commercial companies. Provision of all cultures, except experimental strains, incurs a modest fee to cover materials.

Waite Campus Mass Spectrometry Facility

Staff

Yoji Hayasaka and Gayle Baldock

Role of Waite Campus Mass Spectrometry Facility

The three important roles of the Waite Campus Mass Spectrometry Facility are to act:

1. as a leader in the application of mass spectrometry to grape and wine research;
2. as an investigator to solve the problems facing the wine industry and individual winemakers, using mass spectrometric techniques; and
3. as a collaborator with The University of Adelaide, Provisor and CSIRO in the research activities involving mass spectrometry.

Mass spectrometry facility usage trends

The demand for electrospray ionisation – mass spectrometry for HPLC-MS/MS analysis has remained high in the reporting period. In particular, usage of HPLC-MS/MS by the AWRI for analysis of residues accounted for 60% of the total instrument running time.

With respect to research activities, HPLC-MS/MS was used for a wide range of projects, including research into tannins (11%), interaction of volatile and non-volatile compounds in wine flavour perception (6%), and molecular tools for the evaluation and improvement of wine fermentations (5%).

Usage of the TSQ GC-MS/MS instrument by the AWRI was divided between the Industry Services-Technical Problem Solving group (44%) and *Brettanomyces* Project (36%).

The usage of GC-MS/MS and HPLC-MS/MS for the period between 1 July 2005 and 30 June 2006 is detailed in Table 1.

Table 1. A comparison of the usage for the GC-MS/MS and LC-MS/MS.

	GC-MS/MS	LC-MS/MS
AWRI	80%	73%
The University of Adelaide	20%	27%

Collaboration with the AWRI's Industry Development and Support group and Analytical Service

The capability to monitor contaminants is essential to ensure that potential comtaminations and taints in juice or wine are detected and resolved, and to maintain the quality of our products at a high standard.

The Mass Spectrometry Facility conducted analyses on 375 samples for the investigation of potential taint or contamination problems, in collaboration with staff of the Industry Development and Support group. The analyses conducted during the reporting period are detailed in Table 2.

Table 2. Problem solving investigation conducted in the period from July 2005 to June 2006.

Type of investigation	Number of samples analysed
Brettanomyces Project samples	109
Aromatic hydrocarbon taint	77
Brine contamination	69
2,4 D analysis	61
Hydraulic oil contamination	45
Indole	6
Musty	3
Unknown plastic taint	3
Ethylene glycol	2
Total samples	**375**

For some investigations, method development and improvement was also carried out as follows:

- Methods for the extraction and quantification of 2,4-D in grapes and wine were developed and validated as requested by industry.
- A method for the analysis and quantification of ethylene glycol based brine contamination using HPLC-MS is currently in the initial stages of development.

Procurement of a new HPLC-MS/MS instrument

The AWRI placed an order for an Applied Biosystems 4000 Q Trap tandem mass spectrometer combined with an Agilent 1200 HPLC system in March 2006 and will be installed in July 2006. The new HPLC-MS/MS instrument is fully owned and operated by AWRI; this will enable an immediate response to critical industry issues and will foster grape and wine related research projects.

Upgrades of the existing mass spectrometric systems

The Gerstel Multipurpose autosampler for SPME and liquid samples was installed onto the TSQ GC-MS/MS system in December 2005. This upgrade has reduced significantly the turnaround time for many analyses requested by the Research and Industry Services groups. Also, our ability to efficiently develop and validate methods has been significantly enhanced and the ability to automatically run samples on a 24-hour cycle has improved the efficiency of this system.

While the API-300 HPLC-MS system, funded with the University of Adelaide, is 10 years old, it has maintained its original mass spectrometric capability and performance. To extend the life span and to improve the reliability and productivity of this HPLC-MS instrument, new Agilent 1100 binary HPLC pumps, degasser and thermostatically controlled column compartment were installed together with a new computer and the latest 'Analyst' software.

Team reports

Wine and oxygen: towards an optimised management of wine manufacturing, maturation and storage

Staff

George Skouroumounis, Mariola Kwiatkowski, Liz Waters.

Wines can be placed at risk of oxidative spoilage and premature development through packaging, transport and storage decisions. At present the industry has little in the way of tools to predict shelf life because the factors likely to impact on it are poorly understood. In particular we lack information about the factors with the greatest influence on oxygen ingress rate and we cannot accurately quantify the amount of oxygen likely to be introduced into bottles during packaging and wine transfer operations.

Our efforts in this area aim to 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. An important tool that will enable us to be successful is the development of a method to quantify oxygen ingress into wine bottles. The assay developed in and for this project uses a water-soluble compound to trap singlet oxygen. Our current data indicate that the assay allows us to estimate, within six to eight weeks, both oxygen ingress rates: an estimate of the initial amount of oxygen in the headspace of a wine bottle and the amount of oxygen entrapped in the closure.

Red wines and closures

A study was initiated to gather preliminary information about whether a red wine under screw cap develops more 'reduced' (rubbery, struck flint-like) aroma, altered colour and sensory properties than under natural cork and to evaluate whether headspace volume under the screw cap effects these differences. A Cabernet Sauvignon wine was bottled using commercial bottling equipment with a ROTE seal (Auscap), and air headspaces of 4, 16 and 64 mL, or natural cork (Reference 2) or a synthetic closure.

The concentration of free and total SO_2, and phenolic compounds including anthocyanins, selected pigments, pigmented polymers and tannins, and colour measurements using Somers' and CIELab methods have been determined in the wines over a two year storage period. In addition, analysis of the aroma and palate properties of the wines has been performed after 6, 9, 11, 18 and 24 months storage. Wines were also scanned using a FOSS NIRSystems6500 in transmission mode (in bottle and cuvette), on the same day that chemical and sensory analyses were performed.

The data collected throughout the storage trial has been analysed with the help of principal component analysis (PCA) and partial least square (PLS) regression models. Correlations were found between the VIS-NIR

spectra and the CIELab and Somers' colour parameters as well as other compositional parameters. In addition, the use of VIS-NIR showed promise as a tool to estimate the sensory scores for attributes of the red wines in this study and some of their compositional parameters. This study demonstrates the potential of the use of VIS-NIR to measure both colour and sensory parameters of wines from highly replicated research experiments. The use of VIS-NIR represents an opportunity to reduce the number of compositional and sensory analyses required and thus the overall cost of research.

The overall conclusion from the data is that the red wines sealed with a natural bark, a synthetic closure or under a screw cap with the intermediate headspace volume, were all very similar. Only the wines sealed under screw caps with extreme differences in headspace volume (4 mL and 64 mL) showed differences in analytical or sensory parameters, and only time will tell whether those differences have commercial significance.

White wines, closures and ascorbic acid

The influence of ascorbic acid on browning of white wines has been the subject of many research papers. We have brought to a close in this project a large collaborative investigation to assess the development of a Riesling and wooded Chardonnay wine over five years following the imposition of several treatments at bottling, including ascorbic acid addition. The wines were bottled with and without added ascorbic acid, and under a screw cap closure, two different natural corks and a synthetic seal. In addition, the effect of storage orientation was investigated. The bottled wines were stored under controlled temperature and humidity conditions.

The wines were assessed for the degree of visual browning and the same samples were also scanned in the bottle using a modified Shimadzu spectrophotometer. The spectral and visual assessment data were combined with *The Unscrambler* software to determine the optimal method for estimation of browning from the spectral information. Partial least squares (PLS) regression was used to predict brown rating using absorbance at 400 to 800 nm. The regression coefficients for the factors used in the PLS algorithm peaked at 478 nm for both wine types. Linear regression profiles for the correlation of browning with absorbance differed for the two wine types, but a common, single wavelength (500 nm) could be used to measure browning in both wines. Linear regression using absorbance at 500 nm and PLS using 400 to 800 nm gave similar results (in terms of standard errors) and the accuracy of both methods was comparable with the original visual assessment method. Both regression methods gave better performance than linear regression using absorbance at 420 nm, the wavelength commonly used to assess browning.

After three, four and five years of storage various other analyses were also carried out on replicate bottles from each treatment, including sulfur dioxide and ascorbic acid concentration, sensory analysis of appearance and aroma attributes, and spectral measures. The largest treatment effect was the closure, with the wines bottled with the synthetic closure being relatively oxidised in aroma, brown in colour, and low in sulfur dioxide compared to the other closures. It was also observed that the wines in this study were less oxidised in aroma and colour after storage for two to five years when ascorbic acid was added at bottling. A number of other differences were also observed such as the higher retention of free and total sulfur dioxide in wines with added ascorbic acid at bottling than the wines without, irrespective of closure type (AWRI publications #877 and 878).

Industry development and support: extension and information transfer

Staff

Peter Godden, Adrian Coulter, Mark Gishen, Geoff Cowey, Matt Holdstock, Narelle Cream, Emma Kennedy, Con Simos.

The Industry Services team provides a wine-making consultancy service principally through the Group Manager of Industry Development and Support, Peter Godden, a qualified and experienced winemaker, Adrian Coulter, a Graduate in the Diploma in Oenology from The University of Adelaide, and Mark Gishen, a qualified chemical engineer with a masters qualification in mechanical engineering science. Mark had gained six years wine industry experience before joining the AWRI in 1994. The team was augmented during the year with the recruitment of Con Simos as Manager of Industry Services. Con joined the AWRI from Cassella Wines and has extensive winemaking experience in several countries. Of the other members of the team, Geoff Cowey (BSc), who had gained five years of wine industry experience before joining the AWRI in 2001, completed his undergraduate studies in

winemaking at Charles Sturt University during the year. Matthew Holdstock (BSc) is also a Graduate in 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. Both Geoff Cowey and Matthew Holdstock will continue to develop their winemaking skills for the benefit of the Australian wine industry, when they each work with high profile wine producers in Europe during the 2006 northern-hemisphere vintage.

Most queries received are technical in nature and arise predominantly from Australian winemakers. However, many queries are also received from wine industry suppliers and Government bodies, as well as a relatively small number from the general public and secondary and tertiary students. The majority of queries are answered either by telephone or increasingly by e-mail. Thus, Industry Services staff supplies approximately five hundred 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, both on the AWRI's own, and other web sites, and the support facilities provided by other AWRI research and library staff members are important in supplying relevant information to callers. Furthermore, the analytical capacity of the Industry Services Laboratory plays an important role in responding to many of these enquiries.

A summary of the enquiries received by Peter Godden, Adrian Coulter, Con Simos, Mark Gishen, Geoff Cowey, Matthew Holdstock and Ella Robinson, during the last three years is presented in Table 3.

Table 3. Enquiries received by advisory staff during the past three years.

	2003/04	2004/05	2005/06
Wineries	1220	1047	1127
Government organisations	57	101	55
Other	431	326	534
Students	40	28	29
Total	**1748**	**1502**	**1745**

The current year figure shows a 16% increase in the number of enquiries received, compared to the previous year. The total of 1745 calls recorded for the year is only three short of the highest figure ever recorded (1748 in the 2003/2004 year). 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 an important or primary source of technical information.

The Investigative and Advisory Services are supported by Roadshow seminar and workshop tours which are currently made on a rotating basis to 28 Australian wine regions. The number of regions visited continues to increase, with


Peter Godden

a dedicated Langhorne Creek seminar being staged for the first time during the year, and the 29th region, New England, will be visited for the first time on a Roadshow planned for January 2007.

During the year, Roadshow seminars and or workshops were held in Griffith, the SA Riverland, Mildura, Hobart, Launceston, Barossa Valley, Langhorne Creek, McLaren Vale and the Adelaide Hills, and events were planned for the second half of 2006 for remaining South Australian Regions and Victoria.

Roadshows are generally organised in conjunction with winemakers' and growers' associations, and for seminars those associations are asked to select the presentations to be made from a list of approximately 60 areas of current AWRI activity, in order 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 by the Industry Services team. 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.

Additionally, during the year Industry Services staff participated in all of the special Roadshow seminar series' that was organised to celebrate the AWRI's 50th Anniversary. Details of the presentations made by the team at Roadshow seminars and workshops, the 50th Anniversary Seminar series, and at many other events, are listed in Appendix 1.

The nineteenth and twentieth Advanced Wine Assessment Courses were held in September and October 2005, providing a further sixty participants the opportunity to develop and test their sensory evaluation performance. Both of those courses were presented under a four-day format, which includes over 40 hours of activities over the four days, and 14 leading wine show judges, journalists and winemakers assisted in the presentation of each course.

The Industry Services team continue to develop the Practical Solutions section of the AWRI website. The AWRI has a vast amount of collective knowledge pertaining to grape and wine production, much of it generated over the years by research and Industry Services' projects, that have been supported by industry research-levy funding. Although this research has produced many technical publications, there is also a great deal of information generated and recorded in a more informal manner by the staff concerned. In addition, a great deal of data pertaining to the composition of Australian wine is stored in various databases at the AWRI, some of which have been in existence for several decades. Collectively, this information is a resource of great potential value to the Australian wine industry. The Practical Solutions website project therefore seeks to make a record of this information, so that it can be delivered to the industry in a manner in which it is both readily useable, and relevant to those involved in day-to-day wine production. The development of these resources will be ongoing, and many areas of interest to winery technical personnel will be addressed in due course.

New material is periodically added to the website, and the existing information is enhanced. Australian wine industry personnel can access the information at *http://www.awri.com.au/practical_solutions/* or, alternatively, via the AWRI Home Page by selecting 'Practical Solutions', followed by 'Hazes and Deposits' and 'Microbiological Instabilities'. This section of the site is password protected (the password has previously been supplied to Australian wineries). Australian grapegrowers and winemakers who require the password, and who can confirm that they pay the Wine Grapes or Wine Research Levy, can obtain it from the AWRI, email *rae.blair@awri.com.au*. However, other sections of the AWRI website also contain a great deal of other technical information, which is readily accessible by all interested parties.

Planning for the 13th Australian Wine Industry Technical Conference began in earnest during the reporting year. The Manager of Industry Services became a member of the main conference organising committee, and the Group Manager of Industry Development and Support became the joint chair of the program committee. In addition, the Group Manager, in conjunction with the Administrator – Industry Development and Support, has responsibility for organizing and staging an extensive workshop program at the conference.

Industry development and support: technical problem solving and consulting

Staff

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

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 4.

The figure for the number of investigations conducted is nine per cent higher than the previous year and the total number of samples analysed as part of these investigations increased by 30%. The considerable increase in the number of samples analysed is accounted for by samples analysed as part of major investigations into the nature of 'unknown' taints, some individual cases of which are described in detail below. The number of wines that are determined to be contaminated or tainted with substances that are not permitted additives to wine is 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.

Approximately 42% of investigations conducted during the current year related to the combined problems of hazes and deposits and microbiological instabilities. Whilst this figure represents a decrease of 13% from the average (55%) for the previous two years, 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 4 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.

Table 4. 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.

Investigations conducted and samples analysed			
	2003 /04	2004 /05	2005 /06
Identification of hazes and deposits	87	86	107
Microbiological investigations	93	107	47
Sensory assessments	60	42	37
Taint problems	46	31	118
Other investigative analyses	36	66	48
Closure-related investigations	19	5	11
Total number of investigations	**341**	**337**	**368**
Total number of samples analysed	**1262**	**736**	**2255**

The types of investigations recorded in Table 4 are extremely varied, and some particularly interesting and unusual cases have been investigated during the year.

- During the last twelve months the Industry Services team conducted several investigations into wines that were identified as containing calcium-DL-tartrate instabilities. Calcium-DL-tartrate instabilities have resulted in a number of problems for the wine industry in the past and have been associated with the use of synthetic or racemic DL-tartaric acid. However, during the recent investigations it became apparent that the instabilities were not necessarily due to the use of synthetic or racemic DL-tartaric acid. Analysis of tartaric acid samples that had been retained by some of the wineries involved showed that they were in fact the natural L-tartaric acid. This led the Industry Services team to investigate the possibility that racemic DL-potassium hydrogen tartrate (DL-KHT), used for 'seeding' tanks during cold stabilisation, might be responsible for observed instabilities. Analysis of samples of KHT from four of the wineries which had retained samples of batches of KHT revealed that they were indeed racemic. It is therefore assumed that the calcium-DL-tartrate instabilities in the wines from at least four of the wineries were caused by the addition of racemic DL-KHT 'seed crystals' during cold stabilisation of the wines. Calcium-DL-tartrate instability arising from the addition of racemic KHT has apparently not previously been observed at the AWRI, or has not been attributed to the use of such KHT.

  Industry Services staff subsequently contacted the winemakers from the four wineries that retained KHT batch samples and asked them to outline the stabilisation method utilised. It was hoped that discussions might reveal some point in the procedure where DL-KHT might have been able to dissolve in the wines. Cold wine (below zero °C) should be supersaturated with KHT, and it would therefore be expected that DL-KHT (or KHT) seed crystals added to a cold wine would not dissolve. However, if a cold wine containing DL-KHT (or KHT) seed crystals was allowed to warm up, then it is possible that some seed crystals could dissolve, making the wine susceptible to later calcium-DL-tartrate deposition. In order to avoid this it is essential to filter wine at the seeding temperature, following contact seeding, to avoid the KHT crystals dissolving into solution.

  After discussions with the winemakers it was evident that the above scenario was the most likely cause in three of the wines with the instability, as the winemakers had allowed the wines to warm up before filtering to remove the crystalline deposit. In the fourth case, it is suspected that the cause of the problem might have been inadequate filtration following contact seeding. It is interesting that three of the wineries with the calcium-DL-tartrate instability were situated in the same region and purchased KHT from the same supplier.

- Finished, bottled wine samples sealed with natural cork closures are commonly submitted for investigation of cork taint-type problems and have been discussed in many Annual Reports over the past 15 years. Seventeen investigations relating to 'musty' or 'TCA-like' aromas in wines were conducted during the year and 13 of these problems have been determined to be due to chloroanisoles originating from natural cork closures after bottling. Occasionally however, samples of wine from oak barrels are also submitted for investigation of 'mouldy' or 'TCA-like' taints. In one case recently investigated, all of five 2005 vintage Pinot Noir wine samples submitted by a winery (from five different barrels) were each determined to contain 2 ng/L of TCA. Discussions with the winemaker revealed that the wine had been pumped out of barrels into tank and then back into barrels before the taint was

observed. This case exemplifies the need to screen all barrels by sensory assessment before such operations are performed, assuming the TCA taint originated from a small number of tainted barrels, in order to avoid tainting the whole batch of wine.

In another separate case, six barrel samples of another 2005 vintage Pinot Noir wine were submitted in order to investigate the possibility that one or more of the barrels in which the wine was stored might have been contaminated with TCA. The winemaker had been advised by a wine taster who was reported to be 'sensitive to TCA', that a blend of the wine from the six barrels was affected by TCA. All six barrel samples were tested for the presence of both chloroanisoles and 2,4,6-tribromoanisole (TBA) because the AWRI sensory panel was divided on ratings for the presence of TCA in the samples, with some tasters simply noting a 'musty' taint. All six of the barrel samples were determined to contain TBA, ranging in concentration from 2 ng/L to 5 ng/L. The sample that was determined to contain 5 ng/L of TBA was the one that the three AWRI tasters agreed was most likely to be tainted. Since the AWRI's Analytical Service introduced testing for TBA as part of the chloroanisole analysis during March 2005, approximately 30% of all samples analysed for chloroanisoles have been found to contain TBA. It is therefore suspected that TBA might have been responsible for some of the musty-type taints in wines investigated by the AWRI in the past, but which were found not to contain detectable levels of chloroanisoles.

The compound TBA is a molecule which behaves like TCA and produces a similar, but subtly different taint. It is likely that members of the AWRI sensory panel will become increasingly able to reliably distinguish between the two taints. The precursor of TBA is 2,4,6-tribromophenol (TBP), which is converted to TBA by microbial methylation (in the same manner that 2,4,6-trichlorophenol is converted to TCA). TBP is both a flame retardant and fungicide, and is widely used to treat wood and wood products. In addition, TBP can be produced by some algae and is also found in detergents containing bromine. TBA is extremely volatile and has been found on winery surfaces including barrels, plastics (including synthetic closures and silicone barrel bungs), natural corks and wood structures including walls, floors and ceilings. TBA has a perception threshold approximately the same as TCA (Zoecklein 2004).

- Occasionally, raw materials or finished products are determined to have become tainted with foreign substances after having been transported in shipping containers. Recently, samples of several consignments of wine that had been shipped overseas in flexible bulk wine containers were submitted for investigation after the wine products had been rejected by an overseas customer. Control samples of the wine products that had not been shipped in the flexible bulk containers were also submitted for comparison.

  Aroma assessment of the wines indicated that those shipped in the flexible containers had acquired a taint that was described by the assessors as 'plastic', 'styrene', 'mothballs', 'naphthalene' and 'chemical'. Subsequent analysis of the wine samples by gas chromatography-mass spectrometry (GC-MS) revealed that the wines shipped in the flexible containers had detectable levels of xylene, naphthalene and methylnaphthalenes that were not detected in the control samples. Some of the tainted samples also contained detectable levels of alkylbenzenes. As none of those taint compounds were detected in the control samples of the wines, the contamination must, therefore, have taken place at some stage during transportation.

  Xylene and its isomers are used as solvents in the paint industry whilst alkylbenzenes have been previously detected in wines contaminated with diesel or other petroleum-derived products. Naphthalene is a constituent of diesel and jet fuels and is also a constituent of consumer products such as mothballs, toilet deodorants and shaving brushes, and is a constituent of creosote used for timber impregnation. Naphthalene is widespread throughout the environment and is ubiquitously discharged by incomplete combustion processes from industrial, domestic and natural sources, such as motor vehicles, shipping and air traffic, residential heating with fossil fuels, gasoline burning, industrial plants and forest fires. In a previous investigation conducted by the AWRI, into wines that had become tainted with TCA after transportation in flexible containers, there was strong evidence that the tank liner was a poor barrier to TCA and that TCA diffused through the liner into the wine during transport. It is possible that the wines discussed above might have become tainted after the flexible bulk wine containers were exposed to an atmosphere containing the taint compounds. However, the flexible container material itself cannot be ruled out as a possible source of the taint compounds as that material was not tested.

- Variable, post-bottling growth of *Dekkera/Brettanomyces* yeast has been reported by French researchers (Chatonnet et al. 1995, Ribéreau-Gayon et al. 2000), where different bottles of the same wine were found to contain different levels of 4-ethylphenol (4-EP) some time after bottling. Two such cases were investigated by the AWRI during the year. In the first case, a winemaker submitted samples of a Shiraz wine, which had been bottled approximately a year earlier, because he had noticed signs of *Brettanomyces* yeast spoilage. The winemaker indicated that all the components that made up the final blend of the wine had been analysed for the concentration of 4-ethylphenol and were all determined to be below 350 µg/L.

  Analysis of eleven bottles of the wine, which were sealed with natural cork closures, revealed that the concentration of 4-EP ranged from a minimum of 675 µg/L to a maximum of 1350 µg/L. The concentration of glucose plus fructose (G + F) in the bottles ranged from 0.1 g/L to 0.3 g/L. The bottles that contained the highest concentrations of 4-EP also contained the lowest concentrations of G + F, and vice versa, whilst the concentration of acetic acid in the bottles did not vary from 0.57 g/L. All the bottles of wine were found to contain viable yeast during microbiological analysis, which were suspected to be *Brettanomyces* sp. based on their cellular morphology.

  In the second case, a winemaker submitted bottles of a Shiraz wine for investigation because he had observed variation in characters he believed were due to *Brettanomyces* yeast. The components of the wine were racked from wood and filtered into a single tank prior to bottling the first batch of the wine, in bottles sealed with natural cork closures, over two consecutive days. Approximately one week later the remainder of the wine was packaged using bottles sealed with screwcap closures, with the addition of sulfur dioxide (SO_2) being the only further operation performed on the wine.

  Analysis of twelve bottles of the wine sealed with natural cork closures revealed that the concentration of 4-EP ranged from a minimum of 695 µg/L to a maximum of 1405 µg/L, whilst a bottle of the wine sealed with the screwcap closure was determined to contain 35 µg/L of 4-EP. The concentration of G + F in the wine sealed with the screwcap closure was determined to be 0.4 g/L higher than the mean of the wines sealed with the cork closures, most of which contained greater than 1000 µg/L of 4-EP. All the bottles of wine sealed with the natural cork closures were found to contain viable yeast during microbiological analysis, which were suspected to be *Brettanomyces* sp. based on their cellular morphology; however, no viable microorganisms were obtained from the bottle of wine sealed with the screwcap closure. It is interesting to note that the concentrations of free and total SO_2 (determined by aspiration) in the bottle of wine sealed with the screwcap were 12 and 16 mg/L higher, respectively, than the mean concentrations of free and total SO_2 in the bottles sealed with natural cork closures. It is possible that the higher concentration of SO_2 in the bottle sealed with the scewcap closure, combined with more anaerobic conditions after bottling, rendered any *Brettanomyces* yeast present in the wine non-viable during storage.

- A sample of sparkling base wine was submitted for investigation of a light-purple, 'emulsion layer' in the lower portion of the sample bottle. The clear wine was carefully decanted in order to obtain the 'emulsion layer', which was subsequently examined

using phase-contrast microscopy. The 'emulsion' had the appearance of amorphous material, typical of proteinacious deposits, with some bright, spherical inclusions. The observation of bright inclusions in amorphous deposits is usually indicative of the presence of a metal complex.

A portion of the emulsion isolate was found to dissolve in 0.1 M sodium hydroxide, which is typical of deposits containing protein, but was not soluble in 10% hydrochloric acid solution, in which metal complexes usually dissolve. The 0.1 M sodium hydroxide solution containing the dissolved emulsion material was tested for the presence of copper and iron by atomic absorption spectrometry (AAS). No copper was detected, however the sodium hydroxide solution contained a relatively high concentration of iron, indicating that iron comprised a significant proportion of the 'emulsion'.

The Quality Control Officer of the winery involved, who had also been investigating the problem, was contacted to discuss results and any recent developments. Apparently, the tank containing the wine had old, redundant cooling 'spears' in place, which had been left with a water/glycol mixture in them for a very long time. The cooling 'spears' were removed from the tank and after the water/glycol mixture was drained from them, an obnoxious dark liquid remained. The water/glycol mixture was determined to contain a high concentration of iron, suggesting that the cooling 'spears' had rusted internally.

Iron has great affinity for ligands that coordinate with oxygen, such as polyols like glycerol (Cotton and Wilkinson 1980). It is suspected that the cooling 'spears' had slowly leaked the iron-rich water/glycol mixture into the tank and in the low pH (3.2) conditions of the wine, and formed an iron-glycol colloidal gel. As both ethylene glycol and diethylene glycol, which are used as antifreeze agents, are denser than water, it would be expected that any iron-glycol colloidal gel that might form would form a layer at the bottom of the tank (or sample bottle, as observed). Transition metal complexes can form many colours and at very low pH, iron (III) can form the hexaaqua ion which is purple. However, as the pH is raised to around 3, more highly condensed species are formed, attainment of ligand equilibrium becomes sluggish and consequently colloidal gels are formed (Cotton and Wilkinson 1980).

All the redundant cooling 'spears' were removed from tanks and the winery involved has not encountered any further problems with purple 'emulsion layers'.

Investigations conducted into the nature of 'unknown' taints observed during the year

During the past 12 months, Industry Services Staff have spent a large amount of time dealing with 'plastic/chemical-like' taints observed in wines from the 2005 and 2006 vintages.

The considerable involvement of other AWRI staff, particularly Dr Leigh Francis, Dr Mark Sefton, Dimitra Capone, Katryna van Leeuwin and Creina Stockley is acknowledged, as is the involvement of the AWRI's Analytical Service in expediting the analysis of many samples as part of these investigations.

The Industry Services Team considers that the investigations conducted into the nature of these 'unknown' taints, when viewed collectively as one issue, represent the largest systematic examination of a problem dealt with since the inception of the team. The investigations began with an approach from a senior winemaker from a medium-sized winery who considered that a large number of the winery's 2005 vintage wines, which had been made on contract at another facility, were affected by a 'plastic/chemical-like' taint. The winemaker estimated that the total volume of wine suspected to be tainted was in the order of 1 million litres, representing a range of wines covering many price points. This highly experienced winemaker presumed the taint was due to chlorophenol compounds. The terms used by AWRI tasters to describe the taint character observed during sensory assessment of tainted wine samples, such as 'plastic', 'painty', 'medicinal', 'phenolic' and 'chlorine-like', were indeed consistent with those commonly used to describe chlorophenol taint. Additionally, some tasters did not perceive any taint at all, a phenomenon typically encountered with chlorophenol taints.

However, subsequent analysis using gas chromatography-mass spectrometry (GC-MS), conducted on numerous wine samples identified as tainted, by both the winemaker and AWRI tasters, failed to reveal the presence of the chlorophenol compounds typically determined to be responsible for 'plastic/chemical-like' taints in wines investigated by the Industry Services Team, noting that the detection limit of the analysis for these chlorophenol compounds was in the order of 1 to 5 µg/L. Further GC-MS analysis of tainted wine samples for the presence of certain aromatic hydrocarbon taint compounds, occasionally identified as responsible for plastic/chemical-like taint in wines during previous investigations, failed to elucidate any cause of the observed taint.

Meanwhile, several other wineries from various regions in Australia submitted wine samples suspected of being affected by 'chemical' or 'plastic-like' taints. By this time, the total volume of wine suspected to be tainted was in excess of five million litres. Sensory assessments conducted at the AWRI revealed that many of these wines displayed 'plastic/chemical' and 'plasticine' aromas and were affected by a 'chemical-like, hot and burning' aftertaste on the palate. Although many of the wines displayed similar taint characters, subtle differences existed between wines from different companies and the tasters appeared to vary in their sensitivity to the taint characters.

Given that the compounds typically responsible for 'plastic/chemical-like' taints did not appear to be responsible for the observed taints, and given the number of instances of 'plastic/chemical-like' taints was increasing, the Industry Services Team sought assistance from the AWRI's Sensory Team and Flavour Volatiles Team to help characterise and identify the compound (or compounds) responsible.

Whilst investigations are continuing and the significance of a number of taint compounds that have been identified as possible contributors to the taint observed in some wines has not yet been fully elucidated, it appears at the current point of the investigations that three main compounds, either present in isolation or in combination, have been largely responsible for the characters observed in the tainted wines. These three main compounds and the investigations relating to them are discussed individually below.

Sensory analysis

From the early stages, the objective of these investigations was to provide conclusive evidence that wines were tainted, and to identify the compounds that may have been responsible for any contamination. As chemical analysis had failed to provide this evidence, it was decided that sensory analysis methods, yielding quantitative, statistically analysable data, would be required to confirm the presence of taint in the affected wines. A protocol for such an assessment was prepared according to Australian Standard methods.

Although differences existed between the perceived taint characters between some of the tainted wines, suggesting that there might be more than one 'type' of 'plastic/chemical-like' taint, it was considered that the majority (>95%) of wines were affected by a taint that was likely to be attributable to one compound, or one group of compounds with the same functionality. Consequently, the wines comprising this major group were the first to be assessed using the protocol developed and the 'plastic/chemical' taint characters associated with the wines from this group are referred to as *the taint*.

The AWRI sensory panellists were first screened to determine the individuals most sensitive to the taint by presenting them with a number of paired comparison tests. The panellists selected as the most sensitive to the taint then took part in formal rating sessions. Both aroma and palate sensory attributes were rated during the assessments, including *taint aroma* (plastic, chemical, flyspray, chlorine-like), *chemical flavour* (plastic, chemical, flyspray, chlorine-like) and *burning, hot sensation* (burning/hot, lingering, metallic taste). The sensory assessments were carried out in conformance with Australian Standard AS2542.2.3 (1988) and were used to determine the relative degree of taint in particular wine samples. A number of wines that were unrelated to the tainted wines, and that were considered to be untainted, were used as reference wine samples during the assessments. Due to practical constraints, not all wines suspected of being tainted were included. However, a total of 60 wines suspected of being tainted were subjected to the sensory analysis.

The results of statistical analysis of variance (ANOVA) of the data obtained from the panel demonstrated that at least 50% of the wines assessed were tainted with a chemical-like, plastic, chlorine-like, irritating taint. Although conducted in compliance with Australian Standards, the sensory assessments were carried out as a matter of urgency and, due to practical constraints, a relatively small panel was used with only a single presentation replicate. Consequently, the statistical power to detect small differences was not high. It is thus possible that a higher percentage of wines might have been determined to be tainted if replication had been carried out. In addition, the wines assessed were not finished for commercial sale and it is possible that if the wines had been in finished condition, that is, fined or subjected to other treatments to remove any reductive, oxidative or bitter flavours or flavours from the presence of lees, that 'the taint' might have been more evident.

Given that winemakers at one of the wineries involved, and members of the AWRI sensory panel, reported experiencing a burning sensation on the palate and throat, headache and nausea after assessing tainted wines, further sensory analysis of tainted wines was postponed until the identity and possible toxicity of the compound (or compounds) responsible had been investigated.

Chemical/olfactory analysis

The technique whereby chromatography-mass spectrometry (GC-MS) is combined with olfactory detection, known as GC-MS Olfactory or GC-sniff analysis, was employed to identify the taint compounds discussed below. It should be noted that this technique is difficult to perform and is very time consuming. Numerous samples of concentrated tainted wines and solvent extracts of tainted wines and processing aids were analysed as part of these investigations.

2-chloro-6-methylphenol (6-CC)

It is known that taints can have their origins in raw materials or food additives, whereby the raw material or additive is exposed to airborne or package-related chemicals which can contaminate the raw material or additive (Mottram 1998). After reviewing the additives and processing aids used during production of tainted wines, the winemakers from the first company that contacted that AWRI suspected that yeast hulls might have been a potential source of the taint. The winemakers reported that the yeast hulls used during production appeared to impart a chemical-like aroma to water and wine to which the hulls had been added. Samples of the water and wine soaked with yeast hulls were subsequently forwarded to the AWRI, where a taster known to be sensitive to the chemical/plastic character confirmed the winemakers observations.

The AWRI has previously conducted investigations into wines which had become tainted after contact with processing aids, which were assumed to have been contaminated during shipping or storage. Because of this, the AWRI recommends that wine additives and processing aids be subjected to a simple screening method before use, in order to give an indication as to whether they might impart an off-odour or taint to wine. A new Roadshow workshop which provides wine producers with practical information on how to conduct such assessments was developed and presented for the first time during the current reporting year.

Following is a summary of investigations conducted on samples of yeast hulls, and for the presence of the compound 2-chloro-6-methylphenol:

- A sample of yeast hulls was forwarded to the AWRI where a solvent extract of the yeast hulls was subjected to extensive GC-sniff analyses, the results of which indicated there was only one peak in the chromatograms that corresponded with a chemical/plastic aroma. Mass spectrometry revealed that the compound responsible for the chemical/plastic peak was 2-chloro-6-methylphenol, a chlorophenol compound commonly known as 6-chloro-*o*-cresol (6-chloro-ortho-cresol or 6-CC).

- 6-CC is a known taint compound and has been reported to be responsible for taints in chicken meat (Patterson 1972) and biscuits (Griffiths and Land 1973). Griffiths and Land (1973) reported that the odour threshold for 6-CC in water was 80 ng/L and that the taste threshold of this compound was 50 ng/kg in biscuit.

- Two methodologies for the quantification of 6-CC in wine by GC-MS were developed. One of those analytical methods can quantify the concentration of this compound in white and red wines at levels below 1 ng/L. This analytical method was fully validated using a labelled standard of 6-CC that was produced at the AWRI. The method is now offered as a routine analysis by the AWRI's Analytical Service.

- A large number of wine samples were analysed for the concentration of 6-CC, which was determined to be present from 'trace' quantities (less than 1 ng/L) in some wines, to above 500 ng/L in one badly affected wine. Some wines that were considered to be tainted did not contain detectable levels of 6-CC. Of the wines that were found to contain 6-CC, a large majority of wines were determined to contain this compound at levels less than 20 ng/L.

- Of the 60 wines that had been subjected to the sensory analysis, 15 did not contain detectable levels of 6-CC. The other 45 wines were determined to contain 6-CC at levels ranging from 'trace' to 22 ng/L. No correlations were observed between the levels of 6-CC in the wines and the means of the tasters scores for any of the attributes rated during the sensory assessments. These results suggested that 6-CC was not the major compound responsible for the taint observed in those wines.

- The presence of 6-CC in wine and yeast hulls, at concentrations within 10% of those determined at the AWRI, was confirmed by an overseas laboratory. The presence of a relatively low concentration 2,4,6-trichlorophenol (TCP) was also detected in the yeast hulls by that other laboratory. However, analysis of a 'control' sample of yeast hulls that did not contain a detectable concentration of 6-CC, was also determined to contain a similar low concentration TCP, raising the possibility that TCP might have been a 'background' contaminant in those yeast hulls.

- A small-scale fermentation protocol for the analysis of the processing aids, which was developed by one of the wineries that had tainted wines, was used by the AWRI to test stocks of a number of yeast hulls and fermentation aids held by wineries that had tainted wines.

- A solvent 'soak' method using 98% redistilled ethanol for the extraction of yeast hulls and other wine processing aids and additives was developed, allowing analysis of these materials after three days, rather than the minimum of three weeks previously required using the small-scale fermentation method. This solvent 'soak' method was adopted by the Analytical Service so that analysis of wine processing aids and additives for the concentration of 6-CC could be offered on a commercial basis.

- Three 'batches' of yeast hulls were determined to be highly contaminated with 6-CC, compared with several samples of other batches which were determined to contain a 'trace'. No 6-CC was detected in samples of many other batches. The AWRI worked proactively with suppliers concerned and with the Australian Wine and Brandy Corporation (AWBC), to ensure that stocks of processing aids or additives that might have been contaminated with 6-CC were removed from distribution, while the extent and possible source of any contamination was being established.

- Samples of yeast hulls from the same batch numbers as those found to be contaminated with 6-CC were obtained from overseas, indicating that any contamination of those yeast hulls may have occurred prior to arrival in Australia.

- Many samples of active dry wine yeast and several samples of malolactic bacteria and other additives and processing aids were obtained from the market and were analysed, and none were determined to contain 6-CC.

- The results of analysis of several processing aids and additives, including yeast hulls, suggested that foil packaging may be a better barrier to 6-CC (and to other potential contaminants) than plastic packaging. Two suppliers that have found 6-CC in products packaged in plastic and cardboard packs have indicated that they will be changing to foil packaging by the coming southern hemisphere vintage.

- The results of analysis of holdback samples of yeast hulls suggested that samples of otherwise uncontaminated products may be contaminated from other samples during storage or sampling. It is therefore suggested that if wine producers or suppliers maintain reference samples of processing aids or additives, it is crucial that they are stored appropriately in order to avoid subsequent contamination from other samples. Additionally, it is crucial that any sub-sampling of those retained samples for analysis is conducted in a manner where cross-contamination cannot occur.

- During a two-week period, the AWBC export approval panel rejected four samples for 'chemical-like taints', all of which were subsequently found to contain 6-CC. This is considered to be an outstanding achievement in terms of protecting the integrity of Australian wine, and in aiding the AWRI to more fully understand the taint problem.

  One of those samples was a fortified grape juice product which contained approximately 2 ng/L of 6-CC. A sample of the fortifying spirit, supplied to the AWRI by the producer of the fortified grape juice product, was determined to contain 20 ng/L of 6-CC. The spirit had been supplied to the winery in April 2004, and subsequent investigations indicated that it was predominantly produced from wines of the 2000 vintage. A high level of cooperation was received from the supplier of the spirit, and from a second spirit manufacturer from which a portion of the spirit had originally been obtained. The spirit had been supplied to nine different customers and no other problems had been reported over an approximately three year period since the first dispatch. As the spirit was distilled from wine supplied by a large number of wine producers, it proved impossible to ascertain which producers' wines might have originally contained 6-CC. It also proved impossible to trace either reference samples of the spirit, or of other wines to which the spirit may have been added.

  Wine samples were analysed for the producer of the fortified grape juice product. Fortified wines to which the same batch of spirit had been added were determined to contain 6-CC, but all table wines analysed, except one, were determined to contain no 6-CC. One table wine, a Chardonnay, did contain a trace of 6-CC. It was ascertained that the Chardonnay had been bottled immediately following the fortified grape juice product, and contamination of hoses, filtration media or bottling equipment is considered to be a possible source of the 6-CC in the Chardonnay. Other wines bottled after the Chardonnay on the same day were determined to contain no 6-CC.

  This part of the investigation provided evidence that, although not previously identified in wine, 6-CC had been present in wines produced as early as the 2001 vintage with apparently no consequent adverse effects.

- Two wineries which had been involved with the taint investigations concerning wines from the 2005 vintage, suspected that wines from 2006 were similarly tainted. Extensive testing was conducted on newly-fermented wines, processing aids other than yeast hulls, and in one case on samples of yeast hulls exposed to constituents of newly-laid bitumen at one of the wineries, in order to ascertain the source of any contamination and taint. No 6-CC was detected in any of the samples.

- Samples of hoses which had been used to transfer wines containing 6-CC by two wine producers were analysed, using extraction of the inner surface with acidified redistilled 98% ethanol. No 6-CC was detected in any of the samples.

- Samples of distillate, low wine and wash resulting from the distillation of wines that were tainted, and which contained 6-CC, were analysed. All of the 6-CC was determined to be in the 'ethanolic fraction' of the distillates. It had previously been arranged by the wine producer who had supplied the wines for distillation, that the ethanol resulting from the distillation would be used for fuel, and not for wine fortification.

- A formal toxicology report was obtained on 6-CC, the conclusions of which were consistent with toxicology advice previously obtained from an independent consultant, and also advice obtained from the Department of Health in Victoria, ANZFA, and Leatherhead Food International in the UK. That conclusion was that concentrations of 6-CC up to 22 ng/L (the large majority of wines tested contained less than 22 ng/L) do not pose a health risk.

- Based on this advice, sensory assessment of 6-CC in model wines and in neutral white wines recommenced. The aroma threshold of 6-CC under these conditions was found to be above 16 ng/L. At concentrations of 16 ng/L and above, the aroma characteristics of the samples were inconsistent with those observed in tainted wines that contain similar concentrations of 6-CC. Although some assessors reported slight 'chilli' hotness at the higher 6-CC concentrations in model wines, the incidence and intensity of that sensation was inconsistent with that experienced by the same assessors in tainted wines containing similar concentrations of 6-CC.

  Before the sensory evaluations were conducted, the reference standard of 6-CC to be used was analysed in another laboratory to ascertain its purity and lack of other potentially harmful contaminants.

The assistance of the AWRI's Dr Alan Pollnitz, and of Dr Graham Jones of the University of Adelaide is acknowledged.

Indole

GC-sniff analysis was conducted on two 2005 vintage wines in which no 6-CC was detected but which were considered by members of the AWRI sensory panel to exhibit a very similar taint character as those wines that did contain 6-CC. The taint character was described as 'plastic', 'chemical' and 'styrene-like' by sensitive tasters. Indole was positively identified as the cause of the taint in these wines and a rapid and sensitive analytical method was developed. The concentration of indole in the wines (90 µg/L and 350 µg/L) was considerably higher than the mean concentration of approximately 5 µg/L detected in a preliminary survey of a number of commercially available Australian wines. An informal sensory threshold study was conducted using six tasters who were sensitive to indole and an approximate aroma threshold of 25 µg/L was obtained.

Indole has been implicated in the phenomenon known as untypical (UTA) or atypical (ATA) ageing. Indole, methyl indole and aminoacetophenone, which are related to the metabolism of the amino acid tryptophan, are believed to contribute to this taint. Under certain growing conditions, the grape may accumulate excessive concentrations of these compounds in the bound, glycosidic form. These bound components may later be hydrolysed, or broken, releasing the free odour-active volatiles, resulting in the taint (Zoeckein 2003). Indole is also reported to be an off-flavour in beer formed by contaminant 'coliform' bacteria during primary fermentation.

Since the analytical method for indole was developed, a total of six wines have been determined to be tainted with indole: four still table wines and two tank fermented sparkling wines. It is interesting that in the case of the still table wines, all four had become 'stuck' during primary fermentation, suggesting that yeast stress might be a factor associated with the production of indole.

2,6-Dichlorophenol and other chloro- and bromophenols

It became clear towards the end of 2005 that 6-CC and indole were not the major compounds responsible for the taint observed in most of the tainted wines from the 2005 vintage. Therefore, the wine that had attained the highest mean score for the attribute taint aroma during the sensory analysis, but which contained a relatively low concentration of 6-CC (2 ng/L), was subjected to GC-sniff analysis after pre-treatment to remove many normal wine components that potentially might have interfered with the analysis. The results indicated that there were four peaks in the chromatograms that corresponded with chemical/plastic aromas. One of those peaks corresponded with 6-CC, another corresponded with a bromophenol compound, whilst the two other peaks corresponded with chlorophenol compounds. The peak that corresponded to the most intense chemical/plastic aroma was determined to correspond with the compound 2,6-dichlorophenol (2,6-DCP).

Work was then conducted to develop a sensitive analytical method to analyse for a range of chlorophenol and bromophenol compounds. As at the time of writing the analytical method had only recently been validated, and a relatively small number of wines has been analysed. However, a summary of the investigations relating to 2,6-DCP and other chloro- and bromophenols is provided below.

- Sixteen of the 2005 wines that were assessed by the AWRI sensory panel were analysed for the concentration of a range of chlorophenol and bromophenol compounds. All of these 16 wines were determined to contain 2,6-DCP, including wines that were determined *not* to contain detectable levels of 6-CC. Most of those 16 wines were also determined to contain 2-chlorophenol (2-CP).

- It was established that there was a statistically significant relationship between the concentration of 2,6-DCP in the 16 wines from the 2005 vintage and the results of the sensory assessments for the attribute 'chemical flavour' (R^2=0.302, p=0.0275; n=16). If the data for one red wine sample is removed (an 'outlier'), the relationship between the concentration of 2,6-DCP and the attribute 'chemical flavour' becomes highly statistically significant (R^2=0.6151, p=0.0005; n=15).

- With the data from the red wine 'outlier' sample removed from the calculations, the relationships between the concentration of 2,6-DCP and the results of the sensory assessments for the attributes *taint aroma* and *hot/burning* are also statistically significant. That is, there is a correlation between 2,6-DCP and *taint aroma:* R^2=0.4233, p=0.0086 (n=15); and there is a correlation between 2,6-DCP and *hot/burning:* R^2=0.4972, p=0.0033 (n=15).

- Based on the results of chemical analyses conducted at both the AWRI and a contracted laboratory, yeast hulls that were determined to be the source of 6-CC in a number of tainted wines from the 2005 vintage do not appear to be the source of the 2,6-DCP contamination.

- Some of the 16 wines from the 2005 vintage that were assessed by the AWRI sensory panel were also determined to contain other chloro- and/or bromophenol compounds, including 2,4-dichlorophenol (2,4-DCP), 2-bromophenol (2-BP), 2,4-dibromophenol (2,4-DBP), and a combination of either 3-bromophenol (3-BP) and/or 4-bromophenol (4-BP).

- An aroma detection threshold study of 2,6-DCP in white wine was conducted at the AWRI. The overall best estimate of the aroma threshold of 2,6-DCP for the panel (20 people) was calculated as approximately 37 ng/L, pending further data analysis. However, the best estimate threshold was 7 ng/L for two of the panellists, 14 ng/L for three of the panellists and 28 ng/L for six of the panellists.

- The concentration of 2,6-DCP in the 16 wines from the 2005 that were assessed by the AWRI sensory panel ranged from 1 ng/L to 236 ng/L. The concentration of 2,6-DCP in eight of these samples was above the overall best estimate of the aroma threshold of 37 ng/L, whilst the concentration of 2,6-DCP in 12 of these samples was above the best estimate threshold for the two most 'sensitive' panellists (7 ng/L).

- An aroma detection threshold study of 2-chlorophenol (2-CP) in white wine was also conducted. Whilst a threshold could not be obtained for the whole panel (18 people), an aroma best estimate threshold of 116 ng/L was calculated for a group of nine panellists.

- The concentration of 2-CP in the 16 wines from the 2005 that were assessed by the AWRI sensory panel ranged from 'not detected' to 124 ng/L.

- The aroma detection threshold of 4-chlorophenol (4-CP) was studied and determined to be >640 ng/L. The aroma detection thresholds of 2,4-dichlorophenol (2,4-DCP), 2,4,6-trichlorophenol (TCP), 2,3,4,6-tetrachlorophenol (TeCP) and pentachlorophenol (PCP) were also studied and all determined to be >896 ng/L.

- The concentrations 4-CP, 2,4-DCP, TeCP and PCP, were detected in the 16 wines from the 2005 that were assessed by the AWRI sensory panel, were all below 165 ng/L and substantially below the aroma detection thresholds determined for those compounds.

- The AWRI has been informed by the winery that first contacted the AWRI in 2005 that yeast hulls were not used in the production of their 2006 wines, however, some 2006 wines appear to be affected by a similar taint to that observed in the 2005 tainted wines. Recent analysis of 13 of that winery's 2006 wines indicates that they do not contain detectable levels of 6-CC. However, eight of those 13 wines were determined to contain detectable amounts of 2,6-DCP, which ranged in concentration from 12 ng/L to 109 ng/L. Other chlorophenol compounds were also detected in some of those 13 wines, however, at levels below 40 ng/L.

Conclusion

Whilst batches of yeast hulls used during the 2005 vintage were determined to be contaminated with 6-CC and that this contaminant could be transferred to wine, 6-CC did not appear to be the major compound responsible for the taint observed in most of the tainted wines. However, 6-CC 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. Thus, it is possible that 6-CC might have contributed to the overall taint observed in many of the 2005 tainted wines, to some degree. However, no 6-CC has been detected in 29 wines analysed from the 2006 vintage, even though those wines appear to be affected by a taint similar in nature to the majority of tainted 2005 wines. At the current stage of the investigations, the compound 2,6-DCP appears to be the major compound contributing to the taint observed in the majority of both both the 2005 and 2006 wines. However, other chlorophenol compounds (such as 6-CC, 2-CP, 2,4-DCP etc) and bromophenol compounds that might be present below their aroma threshold concentrations, might also contribute to the taint to some degree.

In addition, the possibility that a compound (or compounds) other than 2,6-DCP (and other chloro- or bromophenol compounds) might be contributing to the taint observed in the tainted wines cannot be excluded at this stage. It should be noted that whilst the overall best estimate of the aroma threshold for 2,6-DCP is 37 ng/L, it is possible that the taste threshold for this compound is considerably lower, as is suggested by anecdotal evidence. However, further testing will be required to confirm or otherwise, that possibility.

Whilst the source of the chlorophenol taint has not yet been identified, it is known that mono-, di- and trichlorophenols can readily be generated by the chemical chlorination of phenol. Chlorine-based sterilising agents, such as hypochlorite solutions, can react with traces of phenol present in materials such as plastic or fibreglass tanks or linings, phenolic-based resins, paints and fittings. Chlorophenols are also generated when wood is treated with hypochlorite solutions and are formed in the bleaching of wood pulp for paper manufacture. Sometimes wooden pallets loaded with cartons are stored near processing areas were disinfectants containing available chlorine are used. In situations such as this, chlorophenols can be generated in the cartons or pallets if they contact chlorine. Saxby (1996) indicates that the presence of dichlorophenols may indicate spillage of phenolic herbicides on the wooden floors of shipping containers. In addition, products such as fibreboard and paper made from recycled materials can contain relatively high levels of chlorophenols, which can then contaminate food products or processing aids packaged in the fibreboard or paper (Mottram 1998).

One previous investigation conducted at the AWRI revealed that wine had become contaminated with 2,4,6-trichloroanisole (TCA) after earth filtration. It was revealed that the diatomaceous earth (DE) had become contaminated with TCA from a wooden pallet on which the DE was stored. 2,4,6-trichlorophenol (TCP) is the precursor to TCA. Thus it might be possible that this type of scenario could occur with other taint compounds, such as 2-CP and 2,6-DCP. In another recent investigation conducted at the AWRI, contamination of wines with mono-, di- and tri-substituted chlorophenols was traced back to a hydrogen peroxide/citric acid sanitiser that had somehow become contaminated with chlorophenols. Contaminations such as this usually result from the contact of chlorine-based sanitisers, such as hypochlorite, with phenol.

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The application of research and development to industry problems and opportunities: investigations into the relationship between *Dekkera/Brettanomyces* yeast and red wines in Australia

Staff

Chris Curtin, Peter Godden, Adrian Coulter, Geoff Cowey, Matt Holdstock, Ella Robinson, Emma Kennedy, Paul Henschke, Narelle Cream, Jennifer Bellon, Mark Gishen.

Collaborators

Miguel de Barros Lopes
(University of South Australia)

The main focus of research into the relationship between *Dekkera/Brettanomyces* yeast and volatile phenol formation in red wine during the past year has been to continue detailed genetic and physiological characterisation of a large library of isolates collected from Australian wines since 2002. This work will enable the identification isolates that differ in wine relevant physiological traits, such as tolerance to inhibitory factors (sulfite, ethanol, high acid etc.) and ability to harvest limiting nutrients (sugar, nitrogen, vitamins), then correlate those traits with genetic markers. Improved knowledge of the relationship between genetic characteristics and physiological capabilities will improve understanding of why some wines appear to develop 'Brett' character more readily than others.

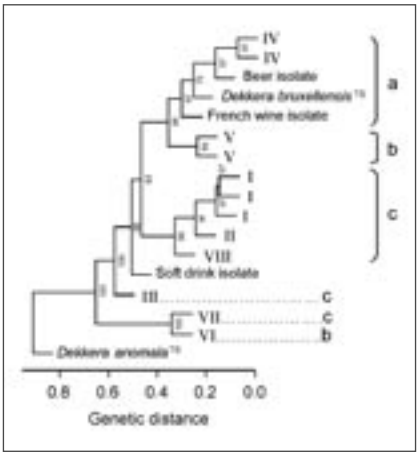


Figure 3. Cluster analysis of AFLP fingerprints for Dekkera bruxellensis *wine isolate genotype groups (in roman numerals) compared with several reference strains. Isolates that exhibited identical 26S ribosomal DNA sequences grouped by lower case letters.*

A highlight of the project this year has been the finalisation of the genetic characterisation of 261 isolates from Australian wines and the communication of these results to industry (Curtin, C.D.; Bellon, J.R.; Coulter, A.D.; Cowey, G.D.; Robinson, E.M.C.; de Barros Lopes, M.A.; Godden, P.W.; Henschke, P.A.; Pretorious, I.S. The six tribes of 'Brett' in Australia – distribution of genetically divergent *Dekkera bruxellensis* strains across Australian winemaking regions. *Aust. N.Z. Wine Ind. J.* 20:28-35; 2005) AWRI Publication #880a, and the scientific community (Curtin, C.D.; Bellon, J.R.; Henschke, P.A.; Godden, P.W.; de Barros Lopes, M.A. Genetic diversity of *Dekkera bruxellensis* yeasts isolated from Australian wines. Submitted to *FEMS Yeast Res.*; 2006) in press.

As reported in the 2005 Annual Report, a large number of isolates identified as *Dekkera bruxellensis* have been analysed by amplified fragment length polymorphism (AFLP), a method recognised for sensitive differentiation of yeast strains. Statistical analysis performed in conjunction with John Field (John Field Consulting) during the past year supported the presence of eight different genotypes (Figure 3), three of which were represented by multiple isolates from several wine producing regions. The vast majority of isolates belong to a single genotype group 'I' (previously designated strain 'A'), which was found in 28 of the 31 wine regions studied. The other major genotype groups were IV and V, which had previously been combined as group 'D' but were able to be separated from one another statistically. These groups were found in seven regions each, and while this was not an ecological study it is interesting to note that isolates with these particular genotypes predominantly came from wine made in cool regions.

Selected isolates representing the eight genotype groups were characterised by sequencing the 26S ribosomal DNA gene, a method commonly applied to species identification. Correct identification of the *Dekkera bruxellensis* isolates in this study was confirmed, while the minor polymorphisms evident provided support for differentiation of the isolates associated with the three major genotype groups. Several isolates did not have AFLP fingerprints that correlated with sequencing, which is not surprising given the greater discriminatory power of AFLP and wider coverage of the genome it offers compared to single-gene sequencing. The combination of markers, however, may prove useful when attempting to correlate genetic data with physiological properties.

High throughput methodologies, essential for screening of sufficient representatives from each genetic group to establish shared phenotypic traits, have been developed and validated for experiments involving carbon source utilisation and sulfite tolerance during the past year. Preliminary results given in the 2004 Annual Report, where a representative of the major genetic group was found to be most tolerant to sulfite compared with the *Dekkera bruxellensis* type strain, have been reproduced using the new high-throughput method. Figure 4 summarises the results of four independent experiments, comparing sulfite tolerance of representative isolates from the three major genetic groups. Isolates representing genetic group I were most tolerant, while the type strain and a representative of genetic group IV tolerated 44% and 34% of the maximum sulfite concentration in which group I isolates could grow, respectively. The other group IV representative was twice as tolerant to sulfite, highlighting the need for screening of multiple isolates from each genetic group to ascertain the true 'group' phenotype.

Further divergence of individual isolates from genetic 'group' characteristics is likely given that mutations affecting phenotype may be

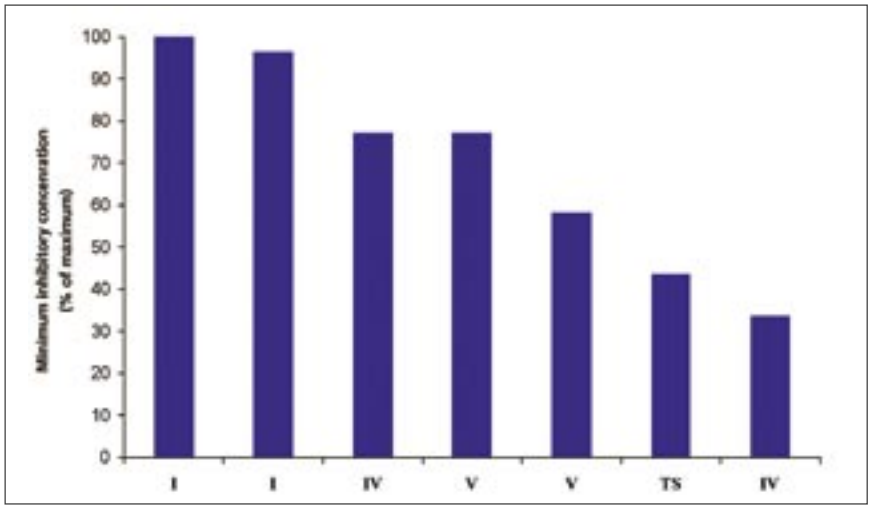


Figure 4. Sulfite tolerance of selected Dekkera bruxellensis *wine isolates from major genetic groups (roman numerals), along with the type strain CBS-74 (TS). Minimium inhibitory concentration compared to most tolerant isolate, determined in chemically defined medium.*

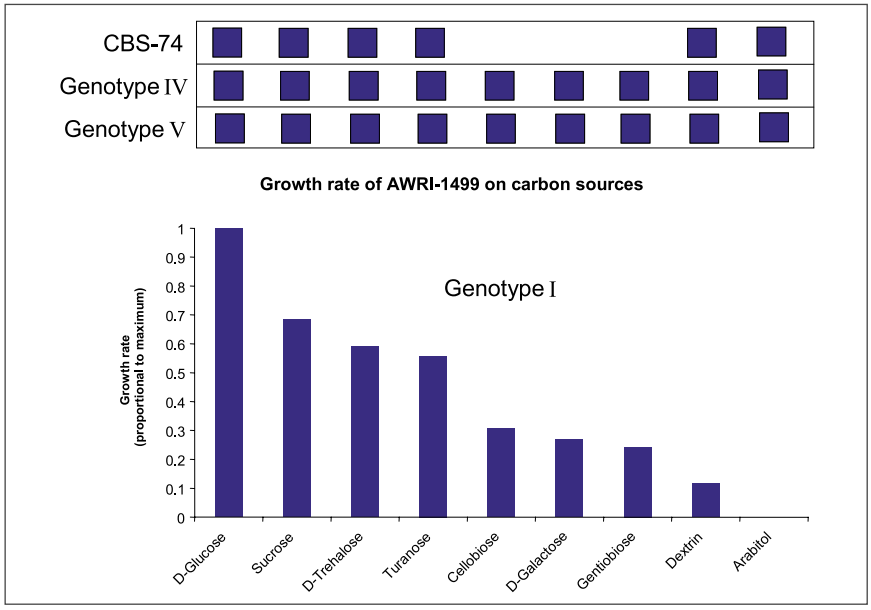


Figure 5. Carbon source utilisation by isolates representing major Dekkera bruxellensis *genetic groups, compared with the type strain CBS-74, as determined in chemically defined medium.*

undetectable by AFLP, although sulfite tolerance is a complex, often multigenic trait. Differences in carbon source utilisation by genetic group representatives will also be expanded in the next year, as there is even more potential for single gene mutations altering this phenotype while remaining undetectable by AFLP. Preliminary qualitative results indicated that the *Dekkera bruxellensis* type strain was unable to utilise several sugars which representatives of each major wine-isolate genetic group could grow upon. Only one carbon source (arabitol), which can be found at trace levels in wine, was differentially utilised by the wine isolates (Figure 5). Future work will take advantage of semi-automated statistical analysis of growth rates, whereby a more sensitive fingerprint of this phenotype can be generated. It is worth noting that while a representative of genotype-I was able to utilise several carbon sources found in wine, such as cellobiose, the growth rate on these substrates is substantially slower than that on glucose.

The incidence of 'Brett'- affected commercially bottled Cabernet Sauvignon and Cabernet Sauvignon/Merlot blended wines from five Australian wine producing regions (Coonawarra, Hunter Valley, Barossa Valley, Margaret River and Yarra Valley) was monitored during the past year through continuation of a compositional survey. The number of samples analysed over vintages from 1996 to 2004 now exceeds 600, and the trend of decreasing mean 4-ethylphenol (4-EP) concentrations reported in previous Annual Reports was reinforced (Figure 6). Application of several statistical tests support a significant reduction in mean and median 4-EP concentrations, in wines made from 2001 onwards, compared to those made from 1996 to 2000. The time from vintage to analysis was not a significant factor when compared to vintage or region, providing further evidence that the observed trend is real. Part of this trend is the increasing number of wines analysed from recent vintages that did not contain detectable concentrations of 4-EP, whereas prior to 2001 only one wine could be considered similarly unaffected by 'Brett'.

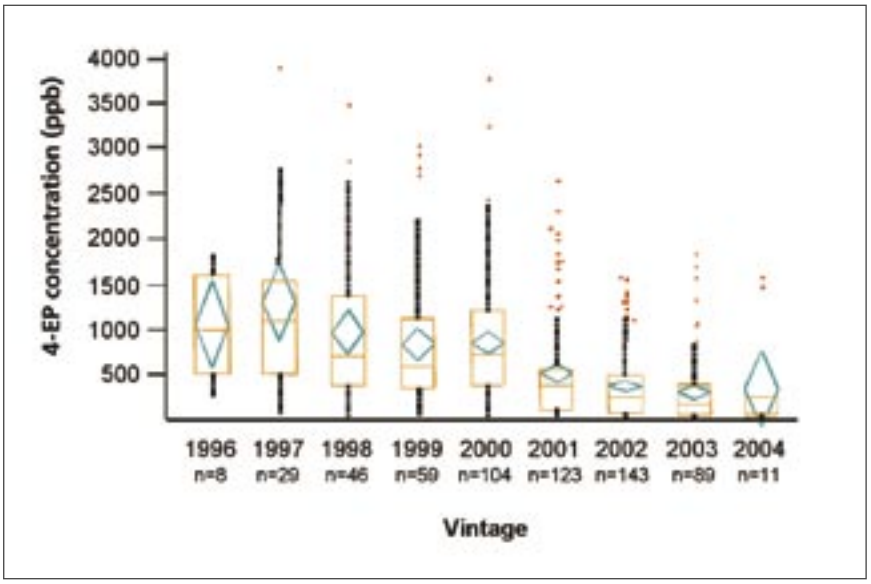


Figure 6. 4-Ethylphenol concentration in Cabernet Sauvignon and Cabernet Sauvignon/Merlot wines made in five regions of Australia (Barossa Valley, Coonawarra, Hunter Valley, Margaret River and Yarra Valley) from 1996-2004. Diamonds represent mean±standard error, box plots are 25-75% quartiles with medians, whiskers include 95% of the data and outliers are indicated by dots.

Furthermore, the proportion of wines with 4-EP concentrations below 200 ppb has increased, such that for one region 80% of wines analysed from the 2003 vintage contained less than that concentration of 4-EP.

One of the aims in conducting the compositional survey is to provide leads for research through observation of correlative variables. In the literature, the ratio of 4-EP to 4-ethylguaiacol (4-EG) is considered reasonably constant, and it is known to influence the perception of 'Brett' aroma. A wide range of ratios, from 4:1 to 40:1, have been detected in wines analysed as part of the survey and the most significant factor correlated with this ratio was region. Statistical tests revealed that two regions for which median 4-EP:4EG ratios were lowest differed significantly from the other three regions. Interestingly, these two regions are on average the warmest of those included in the survey, inferring a link between climate and this ratio.

Anecdotally, there appears to be vineyard–vineyard differences in the propensity of wines to become 'Bretty'. The first phase of a winemaking trial initiated to follow wines made from separate vineyards, with this question in mind, was completed. After 21 months, there was no 4-EP detected in any of the small-scale inoculated or un-inoculated ferments, nor their corresponding commercial-scale wines made from three vineyards. Likewise, no viable *Dekkera bruxellensis* isolates were recovered. The next phase of this work will determine if differences in chemical composition of these wines makes them more susceptible to infection by deliberate inoculation with the *Dekkera bruxellensis* isolates from Australian wine.

Industry development and support: wine technology and processes (incorporating rapid instrumental techniques)

Staff

Mark Gishen, Daniel Cozzolino, Wies Cynkar, Bob Dambergs, Les Jamic.

Research into rapid instrumental methods at the AWRI has been investigating the application of promising rapid analytical techniques such as visible (Vis), near infrared (NIR) and mid-infrared (MIR) spectroscopy. The project has had a primary focus on furthering the development of NIR methods for the 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 analyses of a range of variables important to commercial wine production. Spectroscopic techniques offer the potential to simplify and reduce analytical times for a range of grape and wine analytes. It is this aspect, together with the ability to simultaneously measure several analytes, which was the impetus for developing NIR methods. The measurement of red grape colour (expressed as total anthocyanins) has shown great promise as an indicator of red wine quality, as it has been previously demonstrated that for a set of wines made under carefully controlled conditions with grapes from a specific region, red grape colour was correlated with both wine quality score and wine flavour intensity. However, since the laboratory techniques for the determination of red grape colour are time consuming and laborious, NIR spectroscopy offers potential for rapid analysis.

Transfer of the technology to the industry through direct commercialisation activities, is being carried out under the responsibility of the Cooperative Research Centre for Viticulture's (CRCV) dedicated commercialisation company, CRCV Technologies Ltd. A commercialisation agreement has been reached between an Australian-based spectroscopic instrument manufacturer and the CRCV making possible the development of a prototype rapid and cheap instrument for the industry to measure grape composition. In collaboration with wine industry partners, the prototype instrument has been evaluated during the 2005 and 2006 vintages and feedback was generally positive. Overall, the instrument appears to be sound and is now ready for commercialisation under the agreement. Other significant commercialisation activities have included the submission and granting of Australian innovation and worldwide patents in several applications of spectroscopy and chemometrics including, chemical imaging of mould on grapes, determination of wine composition in intact containers, improved calibration algorithms, as well as development of commercial products of the CRCV-patented reference tiles for Vis-NIR measurement of red grape homogenates. Arrangements for the continuation of all these activities are being negotiated as part of the wind up procedures of the CRCV.

The consolidation of NIR calibrations developed for the analysis of grape berry colour, total soluble solids and pH has continued with the ongoing cooperation of industry partners so that nearly 4000 berry samples from the 1999 to 2006 vintage seasons, and from a wide range of growing regions and red varieties (but predominantly Shiraz and Cabernet Sauvignon), have been scanned with a research grade NIR instrument located at the AWRI and validated by the conventional laboratory method. An important outcome of this work has been the development of an industry standard procedure for the determination of the concentration of total anthocyanins in red grapes — this procedure has been published and disseminated by the CRCV. Furthermore, an inter-laboratory proficiency study for red grape colour testing was conducted using 2006 vintage samples, involving several commercial, and industry and research-based laboratories. Another important output of this project is the database of red grape composition by variety and region of wine grapes grown in Australia over a period of seven years. These data will be disseminated to industry through a publication as they will potentially be of importance to growers and winemakers, and will be the first time that such information has been presented. As reported previously, the project has investigated the possibility of simplifying the sample presentation for NIR prediction of colour, TSS and pH that might dramatically increase sample throughput. These investigations conducted in collaboration with a major winery for whole grape berry presentation were promising, indicating that NIR may have potential for use in the streaming of fruit on receival at the weighbridge or for in-field analysis, although calibration accuracy was diminished for the less processed grapes. One innovation stemming from this work was development of the application of NIR spectroscopy to indicate wine quality and value non-destructively, in-the-bottle, and whilst an

Australian innovation patent has already been granted for this, a world wide patent application has also been lodged.

The project team continues to collaborate with several research teams in investigating further applications of spectroscopy (e.g. NIR, MIR, UV and Vis). These include the discrimination and identification of yeast strains (AWRI Molecular Biology), the detection of moulds in grapes (University of Adelaide), the potential to monitor compositional changes during wine fermentation (AWRI Tannin and Microbiology) and oxidation in white wines (AWRI Oxygen and Wine).

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 promise for the MS-ENose to successfully classify the samples by varietal origin using multivariate methods. Studies have been extended to investigate a range of other applications including the detection of taints, contamination, and wine development monitoring, as well as confirmation of varietal classification, and preliminary results are encouraging.

The team also maintains a strong commitment to the training and teaching of the principles and use of multivariate analysis techniques (chemometrics) to the Australian wine industry, and have developed materials for a workshop for winemakers, viticulturists and laboratory staff that have been presented at wineries in South Australia.


Mark Gishen

Technical, human and environmental health and management issues impacting on the Australian wine industry – research, repository, interpretation and communication of information

Staff
Creina Stockley and Sakkie Pretorius

Creina Stockley, a clinical pharmacologist, has held the position of Health and Regulatory Information Manager since 1991. One of the activities of the AWRI has been to provide health, regulatory and technical advice and assistance to the Australian wine industry, through the Managing Director, the Health and Regulatory Information Manager and the Industry Development and Support team of which the Health and Regulatory Information Manager is a member. From 1 July 2003, environmental information was added to the position description. From 1 July 2005 until 30 June 2006, 254 independent information requests were received by the Health and Regulatory Information Manager from industry (122), the general public (98) and government (14); of these 102 were health and nutrition related and 141 were science and technical related.

Industry committee membership
During the year, support to the industry has been derived from the Managing Director's membership on the WFA Wine Industry Technical Advisory Committee, the Management Committee for Viticultural Publishing (ASVO), the Royal Agricultural and Horticultural Society's Wine Show Committee, and the South Australian Wine Industry Council, as well as the Council of the Institut des Sciences de la Vigne et du Vin de Bordeaux. One of the important aspects of the AWRI's support of the Australian wine industry is its pivotal role in facilitating the triennial Australian Wine Industry Technical Conference (AWITC), in conjunction with the Australian Society of Viticulture and Oenology. Professor Sakkie Pretorius is the Chair of the 13th AWITC planning committee (see page 9 for complete list).

During the year, the Health and Regulatory Information Manager was a member of the following industry committees: AWBC/WFA Wine Industry Technical Advisory Committee (as Technical Liaison); the AWBC Legislation Review Committee; the Wine Industry National Environment Committee; the CRCV 'Good Environmental Management' Project Reference Group; and was the DAFF nominated Australian delegate for Organisation International de la Vigne et du Vin (OIV) Nutrition and Health Subcommission. She is also a member of the National Drug and Alcohol Research Centre's Young People and Alcohol Project Advisory Group on behalf of WFA.

Technical and regulatory issues
The technical and regulatory support to the Australian wine industry is ongoing as issues are regularly raised by industry or government, both in Australia and internationally and often span several years. During 2005/2006, technical and regulatory information and/or issues that have been reviewed, and material prepared includes: 5-page submission to the US Alcohol and Tobacco Tax and Trade Bureau (TTB) entitled *Proposed changes to the labelling and advertising of wines, distilled spirits and malt beverages regulated by the TTB;* additional

information for the *Submission to request approval of a new food additives for winemaking in Japan* by the Department of Foreign Affairs and Trade, Australia; 18-page submission to FSANZ entitled *Proposal P298_Benzoate and sulphite permissions in food;* 7-page submission to FSANZ entitled *Initial Assessment Report for Application A490– Exemption of allergen declaration for isinglass;* 2-page submission to FSANZ entitled *Draft Assessment Report Proposal P293 Nutrition, Health and Related claims;* 7-page submission to the European Commission, Health & Consumer Protection Directorate-General entitled *Labelling: Competitiveness, consumer information and better regulation for the EU: Health warnings on alcoholic beverages;* and material on the concentration of copper in Australian wines to support an amendment to *Proposal A463 copper citrate* at the behest, and on behalf, of WITAC and/or the AWBC. Reports were also prepared on: the concentration of shikimic acid in wine and anthocyanin profiles in wine for the authentication of Australian wine varieties to assist the German regional government authorities; and the toxicology of 2-chloro-6-methylphenol and related chloro- and bromo-phenol compounds which was utilised in, for example, briefing sheets and guidelines for sensory evaluations. A report entitled *Content of minerals in Australian soils, water, grapes and wines* was also provided to the OIV Commission II (Oenology). The Health and Regulatory Information Manager also coordinates Course 3005WT *Grape industry practice, policy and communication* for the School of Agriculture and Wine at The University of Adelaide. In its twelfth year, 27 students enrolled in the Course, which exposes students to organisational, commercial, environmental, political, societal and technical issues relating to the wine industry's operating environment.

Health and nutrition issues

As part of her responsibilities, a database of research on the beneficial and detrimental health effects of alcohol and in particular, wine, has been established by the Health and Regulatory Information Manager on the internal database of the John Fornachon Memorial Library. 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, the database of research on the health effects of wine has been added to and articles have been prepared for inclusion in the AWRI publication, *Technical Review,* and for other Australian wine industry and international alcohol industry newsletters. Articles and other material have also been prepared for the electronic and print media. For example, two articles have been prepared for the bimonthly international publication, *AIM—Alcohol in moderation,* one article for the monthly *Australian and New Zealand Grapegrower and Winemaker,* and one article (AWRI Report) for the monthly *Australian New Zealand Wine Industry Journal.* The Health and Regulatory Information Manager has co-authored with Dr Richard Harding, Head, Consumer choice, food standards and special projects division, Food Standards Agency (UK) a paper entitled *Communicating through government agencies* which was presented by Dr Harding at the invitation-only *Symposium on moderate alcohol consumption, health risks and benefits* sponsored by the Institute on Lifestyle and Health, Boston University School of Medicine on 18/5/06. The manuscript has been accepted for publication in the peer-reviewed journal, *Annals of Epidemiology.* A paper was also published in the peer-reviewed *Australian Journal of Grape and Wine Research* and another in the *Bulletin l'O.I.V.* An oral presentation was made to the Department of Clinical Pharmacology, Flinders University/Flinders Medical Centre on 26/7/05, A keynote oral presentation was made in Session II Social responsibility of wine consumption at Vindaba 2005 International Wine and Health Conference at Stellenbosch, South Africa on 14/9/05, which is to be published in conference proceedings by the *South African Journal of Enology and Viticulture,* an oral presentation was made to the National Centre for Wine and Cardiovascular Health, University of Alabama, Birmingham, Alabama on 11/10/05, and an oral presentation (invited) was made to the OIV Wine, Health and Nutrition Subcommission meeting in Paris, France on 10/3/06. A poster was also presented at the Second International Conference on Polyphenols and Health, Davis, CA, USA, 4-7/10/05. A 45-minute oral submission was also made to the Victorian State Government via a telephone linkup re the *Drugs and Crime Prevention Committee Inquiry into Strategies to Reduce Harmful Alcohol Consumption* as an Expert. The Health and Regulatory Information Manager also prepared a subsequent submission to the Department of Health and Aged Care entitled *Comments on the Draft National Alcohol Strategy 2005–2009* and redrafted the nutrition and health strategy of the *OIV Strategic plan 2005–2008.*

In addition, the Health and Regulatory Information Manager has enrolled in a 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.*

Environmental issues

Complementary to the AWRI's databases on health effects of alcohol, a database on environmental issues impacting on the wine industry was instigated by the Health and Regulatory Information Manager at the behest of the Wine Industry National Environment Committee (WINEC). The database is a keyword specific alert service and is accessible to the general public without a user name and password, with linkages to industry associations and environmental agencies and authorities. Since its launch in May 2004, the database has received 4491 unique research requests, highlighting the relevance of the service.

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.*

The identification and measurement of potential allergens in wine

A collaborative project between the Department of Allergy, Asthma and Clinical Immunology, The Alfred Hospital/Monash University and The Australian Wine Research Institute commenced on 1 July 2002. The project is funded by the GWRDC through The Alfred Hospital, with the AWRI's Creina Stockley as the project supervisor and Professor Robyn O'Hehir is the principal investigator. The project was developed in response to labelling requirements for potential allergens introduced on 14 December 2002 by Food Standards Australia New Zealand (FSANZ), where use of the proteinaceous processing aids casein, egg white, isinglass, milk and milk products in winemaking requires declaration of use on the label of each wine and wine product.

The project comprises two sections. The first section is the determination of detectable allergenic proteins in wine by establishing an *in vitro* functional assay to determine if wines fined with the proteinacous processing aids are capable of activating blood basophils from subjects with known sensitivity to milk, egg, fish, or nuts, and by establishing a panel of sensitive and specific antigen-++capture ELISA to detect and measure the processing aids casein and potassium caseinate, egg white, isinglass and milk in final bottled wine. The second section is a double-blind placebo-controlled clinical study of fined wines in subjects with confirmed sensitivity to eggs, fish, milk or nuts.

A panel of 113 Australian wines was collected and coded by the AWBC and AWRI for blind analysis by The Alfred/Monash University investigators, and included at least 20 wines that had been fined with: egg white or had whole egg added; casein or potassium caseinate; isinglass; milk; or had non-grape derived tannin added. Four control non-fined wines were also collected.

Clinical challenge of 26 food-allergic and 11 non-food allergic subjects using 26 of the above wines and three control non-fined wines revealed no episode of anaphylaxis and no symptom or sign of adverse reaction consistent with fining agent for the relevant allergic subject group. These findings were supported by the results of *in vitro* basophil activation assays performed using blood samples from the above subjects tested against a larger panel of 100 wines fined with the same panel of agents. Only nine of the 100 fined wines tested gave basophil activation >10% with a ratio above the reference range upper limit of 2.85 for

some subjects, but no pattern could be identified with respect to wine variety, fining agent or geographic indication, or to subject group.

Sensitive enzyme linked immunosorbent assays (ELISA) have also been developed to detect residual fining agents in wine. An ovalbumin (egg)-specific ELISA was established using commercial monoclonal and polyclonal antibodies and used to screen the above panel of 100 wines. Apart from the two wines to which whole eggs had been added rather than being fined with egg white proteins, the concentration of ovalbumin was below the detection limit of the assay (1 ng ovalbumin/L). A casein-specific ELISA and a peanut-specific ELISA also generated in-house failed to detect residual allergens in the fined wines (<8 ng/mL α-casein; <8 ng/mL peanut).

Only a limited number of milk allergic (one) and egg allergic (five) subjects could be recruited for this study due to the paucity of these allergies in adults. Minor symptoms noted by the one milk allergic subject after two blinded encounters with wine fined with milk proteins suggested that milk-fined wines should be further investigated. A follow-up study was, therefore, performed using serum from children with milk and egg allergies in a stripped basophil activation assay. The stripped basophil assay was established and validated using control milk and egg white extracts. Wines fined with egg did not induce a statistically significant increase in basophil activation when cells were resensitised with egg allergic sera compared with control sera, but milk-fined wines caused an increased basophil activation when cells were resensitised with milk allergic sera compared with controls.

Together these findings are consistent with a lack of residual potentially allergenic processing aids in final bottled wine manufactured in Australia at a concentration that could cause an adverse reaction in fish, peanut/tree nut or egg allergic adult subjects. Wines to which whole eggs are added cannot be included in this conclusion; the two such wines in this survey panel contained detectable ovalbumin and were not tested in clinical challenge. The rarity of IgE-mediated milk allergy in adults prevented a statistical analysis for clinical challenge and direct basophil activation with milk-fined white wines, but this rarity makes potential allergic reactions to these food proteins in wine rather a theoretical problem. Nevertheless, the results of the follow-up study of milk-fined wines using a stripped basophil assay suggest that the potential of an allergic reaction in a severely milk allergic child or adult following ingestion of a milk-fined wine cannot be excluded.

A paper has been published in the industry *Australia New Zealand Wine Industry Journal* and another paper has been accepted for publication in the peer-reviewed *International Journal of Nutrition*.

Viticultural practices: ensuring best practice in relation to the use of agrochemicals and other viticultural production; information and determination of the effect of selected viticultural practices on grape and wine composition

Staff

Sally-Jean Bell, Peter Godden

Objectives:

- Assess and disseminate information from a variety of sources where viticulture interacts with oenology.
- Participate in viticultural research on winegrapes in relation to wine quality.

During 2005/2006 the Viticulturist responded to 432 enquiries. Eleven thousand copies of the AWRI annual publication, *Agrochemicals registered for use in Australian viticulture 2005/2006* were produced and the booklet was made available on the AWRI website. The booklet was distributed with the *Australian New Zealand Grapegrower and Winemaker* magazine, the AWRI's *Technical Review* and the tables were featured in the *Australian Viticulture* magazine. The 2005/2006 MRLs for Australia's major export markets were updated for the AWRI website. The Viticulturist and Jelka Software further developed the agrochemical database and updated it for 2005/2006. The common spray diary format, developed in conjunction with industry, was adopted as an industry minimum standard by the Agrochemical Reference Group and by the Winemakers' Federation of Australia (WFA) for 2005/2006. An earlier timeline was achieved in 2006 which resulted in the production of 11,000 copies of the AWRI annual publication, *Agrochemicals registered for use in Australian viticulture 2006/2007* (which has become known in industry as the 'Dog Booklet' due to the illustration used on the cover). Five agrochemical updates were prepared for industry email subscribers (Table 7). The Downy Mildew Spray trial was completed and the final report and review was sent to the GWRDC. A presentation of the results from the Downy Mildew Spray trial was made to the Riverland Wine Industry Council who made a contribution towards the funding of this project. Abstracts of relevant articles for *Technical Review* were prepared. The manuscript *Implications of Nitrogen Nutrition for Grapes, Fermentation and Wine* authored by the Viticulturist and the Principal Research Microbiologist was published in the November issue of the *Australian Journal of Grape and Wine Research*. A summary presentation of this manuscript was made at the AWRI 50th Anniversary Roadshow presentations in Hunter Valley, Canberra, Cowra, Mildura, Margaret River, Mount Barker and Swan Valley. The Viticulturist also participated in the AWRI Roadshow visits to Griffith, Sunraysia, Riverland, Hobart, Launceston, Barossa Valley, McLaren Vale and The Adelaide Hills, delivering presentations entitled – 'Manipulation of phenolic profiles in red grapes and wine by viticultural management', 'Preventing bottle haze in bottled wine', 'Agrochemical issues – selling quality wine', 'The management of Botrytis bunch rot' and 'Salty wine'. Five invited presentations were made at Hardy Wines Growers Meeting; Nitrogen from vineyard to wine; 'Some like it hot 2005' Seminar ('All bottled up – What can you do in the vineyard to affect flavour in the bottle?'); University of Adelaide viticulture and oenology students ('Agrochemical Issues – selling quality wine'), EE Muir and Sons Agronomist and Resellers Annual Seminar Day ('Agrochemical Issues – selling quality wine', 'Phosphorous acid and wines for export'); and Evans and Tate Growers Day ('Maximum Residue Limits and withholding periods', 'Phosphorous acid and wines for export' and 'Resistance management, foliar sprays, Peratec, PMS, wetters and AWIS'). Presentations were also given at the AWRI facilitated Annual Agrochemical Reference Group meeting ('Changes in the 2006/2007 Dog Booklet', 'Phosphorous Acid' and 'Wines for Export'). The Viticulturist reviewed a viticulture Masters Thesis from The University of Adelaide, a journal manuscript for *Journal of Agricultural Food Chemistry* and prepared and submitted a AWRI viticulture 7-year Research Plan for the GWRDC. The Viticulturist attended The 14th International Group dÉtude des Systemes de Conduite de la Vigne (GESCO) Symposium in Geisenheim, the ASVO viticulture seminar (Transforming Flowers to Fruit) and the ASVO oenology seminar (Advances in tannin and tannin management). All of the data from the research project 'The Effect of Vine Vigour and Canopy Management on the Phenolic Composition of Shiraz Grapes and the Resulting Red Wine Quality' were analysed. During the year a poster relating to that project was prepared and presented at GESCO entitled 'Manipulation of Phenolic Profiles in Red Grapes and Wine by Viticultural Management'.

Quality Liaison Manager

Mark Gishen remains heavily involved in the collaborative research project evaluating the use of near infrared spectroscopy (NIRS) for the rapid determination of a number of compositional parameters in grapes, must, wine and grape spirit, and continues to take primary responsibility for the project as team leader. The details of this project are reported elsewhere in the Annual Report. In an expansion of AWRI activities into the area of process engineering expertise, collaborations are continuing with the Department of Chemical Engineering at Adelaide University through co-supervision of PhD and Honours students' projects including: alternative tartrate stabilisation, optimisation of winery scheduling, and monitoring of fermentation. These enhancements, along with other new initiatives in the area of environmental management, have now been incorporated into the activities of the Industry Development and Support group's planned activities as part of the AWRI's 7-year research plan.

Team reports

The AWRI continues to provide advice on quality management techniques to industry through the *From grapes to glass* program, which was published in August 1997 and enhanced with a simple HACCP module in 1999. Industry interest remains greatest in the HACCP module — a simple program delivered in a one-day course that incorporates an HACCP-type (hazard analysis and critical control point) food safety plan. This module was designed to satisfy the requirements of the national food hygiene regulations, and meet the needs of the smaller scale businesses in the wine industry. The *From grapes to glass* program provides a simple and relatively cheap program that uses a staged approach in the attainment of internationally recognised standards, starting from the *Codex* HACCP principles and leading to the full ISO 9000 quality management standard.

Mark Gishen continues to take primary responsibility for the management of the internal quality systems of the Analytical Service, overseeing management reviews, documentation, auditing, and corrective actions, and is the Authorised Representative in respect of its NATA accreditation. Validation reports prepared by the laboratory for several new methods were reviewed or approved and these included: quinoxyfen, spiroxamine, indoxacarb, dimethomorph by GC-MS; sulphur dioxide using flow injection analysis, 6-chloro-o-cresol by SPME GC-MS; and maltose and maltotriose by HPLC. The Analytical Service continues to participate and excel in both national and international proficiency testing programs for routine wine analysis and for agrochemical residue testing. The quality system of the Analytical Service retains its certification by NATA and recognition for compliance with both the ISO17025 quality management standard for testing laboratories and the OECD Principles of Good Laboratory Practice respectively.

Mark Gishen is the AWRI's representative on the Winemakers' Federation of Australia (WFA) working group known as the Legal Metrology Group. This group was formed in response to a proposal put by the National Standards Commission (now National Measurement Institute) and aims to develop a metrological control system for measurement instruments used by wineries for the receival of and payment for winegrapes. The group has already endorsed the standard procedure for determination of the concentration of total anthocyanins in red grapes developed and published through the CRCV as a step in progressing its aims. Mark Gishen is also liaising with another of WFA's committees, the Packaging Committee, as part of the ongoing process of reviewing and updating the industry's *Code of Good Manufacturing Practice* in collaboration with the AWRI's Health and Regulatory Information Manager, Creina Stockley.

Communication and information services report

Staff

Rae Blair, Catherine Daniel, Kate Beames, Ingrid Barratt, Melissa Francis, Sally Kollmann (until 14 April 2006), Claire St George (from 18 April 2006)

The Communication and Information Services team are responsible for the following:

- Australian Wine Industry Technical Conferences
- The John Fornachon Memorial Library
- Communication between AWRI and its stakeholders
- Corporate publications, including *Technical Review* and the Annual Report
- AWRI's website
- VIP visitors
- Media liaison
- Editorial service

The John Fornachon Memorial Library

The John Fornachon Memorial Library holds the largest collection of wine technical literature in Australia. The Library's principal responsibility is to provide technical information to the Australian wine industry and to the researchers of the AWRI. The Library is also used extensively by other groups such as students, institutional researchers, government bodies and private companies (see Table 5 for requests for information serviced during the year).

Information and document delivery services

The Library has excellent access to international databases, particularly in the fields of science, technology and medicine. If requested, the Librarian will carry out online searches on commercial databases on any appropriate topic (on a fee-for-service basis). Alternatively, Library staff can provide, free of charge, a report of relevant articles indexed on the Library's in-house databases. All Australian grapegrowers and winemakers who pay the *Grape Research Levy* or *Winegrapes Levy* can search the library's database directly from the AWRI website.

The library's traditional focus on being a centralised 'one-on-one' service provider has shifted to meet the demands for 24-hour, 7-day per week access to industry-specific trade and research literature that is of interest and relevance to the library's key clientele. In addition to providing personalised information services, which are a pivotal library activity, an increasing amount of time is being devoted by the library staff members to the expansion and enhancement of the library's web accessible services. Table 5 provides information on the number of enquiries serviced by library staff members during the year. Particularly notable is the 124% increase in the number of AWRI publications forwarded from the library in 2005/2006 after a 54% decrease in requests the previous year. This increase in AWRI publications requested from the library coincides with the successful implementation and launch of electronic ordering payment facilities for AWRI publications from the AWRI website in August 2005. Equally notable is the marked decrease in the number of requests for articles indexed in *Technical Review* using the printed order form within the booklet.

	Wine industry		Staff		Other[6]		Total		% change
	2006	2005	**2006**	2005	**2006**	2005	**2006**	2005	**2006**
Information requests	923	1089	920	966	1451	1319	3294	3559	(7%)
Interlibrary loans:									
• requests sent[1]	56	56	551	479			607	535	**13%**
• requests received[2]							76	39	**95%**
Technical Review requests[3]							110	90	**22%**
Technical Review articles forwarded[4]							336	500	(33%)
Articles forwarded[5]							455	396	**15%**
Number of AWRI publications forwarded							618	275	**124%**
Articles photocopied in JFML							1613	2354	(31%)

1 Staff at the JFML sent a request to another library for an article.
2 Requests received by the JFML from other libraries for articles from our collection.
3 Number of requests received for articles published in the Technical Review.
4 Number of articles forwarded (usually more than one article is requested).
5 Number of articles forwarded, excluding staff publications.
6 90% of 'other' requests come from students and Government sources.

Table 5. Summary of information requests during 2005/2006.

AWRI's on-line databases

Usage of the library's web accessible industry databases showed steady support throughout the year (Figure 7), with a slight decrease in the April to June quarter for the 'industry' database. Particularly strong support for the Environment database was evidenced with an average monthly increased usage of 56% in 2005/2006 over that in 2004/2005.

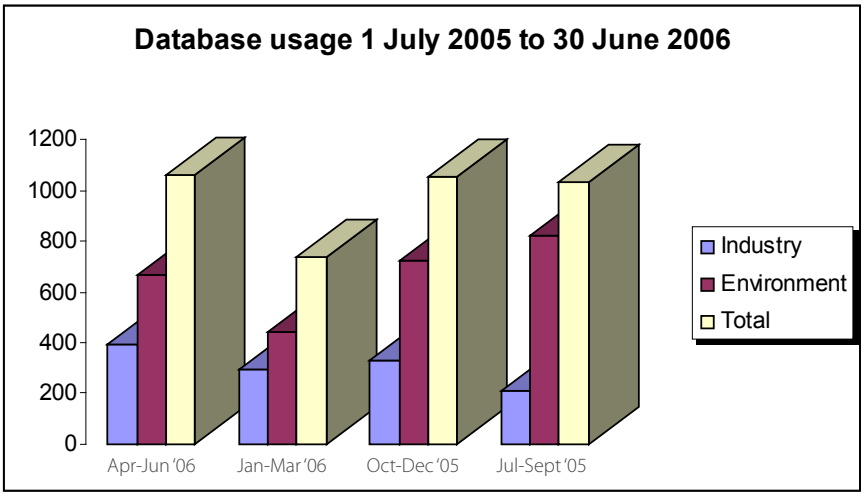


Figure 7. On-line use of the AWRI's 'Industry' and 'Environment' databases from 1 July 2005 to 30 June 2006.

Document delivery

The Library can supply either books or photo-copies from its collection or obtain such items for wine industry clients through the interlibrary system. Patents or standards can also be ordered. Electronic ordering and delivery services mean that most interlibrary requests are fulfilled within five days. Charges apply for the supply of some items.

Specialised information services

The Library staff members continue to be actively involved in the production of specialised information products for the benefit of the wine industry, such as the annual and web-based editions of the *Agrochemicals registered for use in Australian viticulture,* the bi-monthly print and electronic editions of *Technical Review*, and several in-house technical information databases.

Agrochemicals Grid

As reported elsewhere in this Annual Report, Dr Sally Bell and Catherine Daniel prepared the fifteenth edition of the *Agrochemicals registered for use in Australian viticulture.* All levy payers receive a printed copy of the revised edition automatically, and the web-based edition *(http://awri.com.au/agrochemicals/)* is updated on a regular basis.

Technical Review

Technical Review is received by all *Wine Grapes and Wine Research Levy* paying organisations in Australia and, through subscription, by government and other organisations and individuals, both in Australia and overseas. *Technical Review* provides progress reports to the industry on the AWRI's research as well as updates on relevant conferences, regulatory amendments and medical issues. *Technical Review's* 'Current Literature' section provides citation details and abstracts of recently published technical and scientific articles. Recipients of *Technical Review* may order articles featured in the 'Current Literature' section via a request form available within each issue. Restricted password access to *Technical Review* is also available on the AWRI's website *(http://awri.com.au/technical_review/latest_issue/)*. 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.

The collection of the 2005/2006 issues of *Technical Review* has been made available via a CD ROM and distributed free of charge to *Wine Grapes and Wine Research Levy* paying organisations. A simple search mechanism within the CD ROM facilitates fast access to technical notes, current literature abstracts and other matters of interest published throughout the year within the six issues.

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 >1,600 email addresses recorded to receive the email bulletins, and interested members of the Australian wine industry should submit their email address *(to rae.blair@awri.com.au)* should they wish to receive the email bulletins. Nine email bulletins were issued during the year and are shown in Table 6.

Library collection

A total of 187 monographs and 27 conference proceedings and over 2,800 new records were added to the library databases during the year.

The Library subscribes to 54 journals and receives approximately 70 annual reports, journals and newsletters through exchange and donation. The Library also maintains a collection of over 26,000 reprints.

Library databases

A single search screen provides access to the Library's collection of over 52,000 books, conference proceedings, scientific, technical and medical reprint articles which are indexed on the Library's database catalogue; the bibliographic details of the Library's collection of the European Union wine legislation and details of the library's journal holdings are maintained on separate in-house databases.

The Librarian provides reports, either on particular subjects or authors, listing the records retrieved from any of the Library's in-house databases. A summary of the size of the Library's catalogue and information databases is given in Table 7.

The Library provides access to its databases via the internet to Australian winemakers and grapegrowers paying the *Wine Grapes Levy* or the *Wine Research Levy*. The restriction in access is enforced to comply with copyright approvals obtained from the various publishers whose journals are the source of the abstracts that are accessible via the database. Library staff members continue to edit database records to post onto the Library's web database, on an ongoing basis.

Media Library

In 2005, the library received funding to develop a publicly accessible database of wine and grape research images for the benefit of researchers, students and people employed in the grape and wine industries. The library staff members are currently working closely with Dr Bryan Coombe, Dr Bryce Rankine and Dr Peter May to catalogue over 800 images from the combined image collections of these distinguished researchers. Images are also being collected and catalogued from various other industry sources. It is anticipated that the Media Library will be available for public access before the end of 2006. People and organisations wishing to have industry-relevant photographs, wine bottle labels or other relevant images maintained and made available for general use, should contact the AWRI *(email: rae.blair@awri.com.au)*.

AWRI publications database

In August 2005, the library launched its revamped AWRI publications database which incorporates electronic ordering and payment facilities for all AWRI publications. The request and payment details are sent directly to the library via the AWRI website, and each order is processed immediately upon receipt. The success of this service can be measured by the exponential increase in AWRI publications ordered in 2005/2006 (125% increase in 2005/2006 over that ordered in 2004/2005).

The John Fornachon Memorial Library Endowment Fund

The AWRI acts as the Trustee of this fund, which was established in 1969 by donations from winemakers and friends of the late John Fornachon, the first Director of Research of the AWRI. The Library is funded by an annual grant from the Grape and Wine Research and Development Corporation, together with the income generated from investment of the Endowment Fund.

Acknowledgements

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 that 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, Dr P. May, Petaluma Australia, K.F. Pocock, Dr B.C. Rankine, Viticultural Publishing Inc., Winemakers' Federation of Australia Incorporated.

General activities

Commemorating AWRI's 50th anniversary

The first half of the financial year was spent coordinating and presenting at the AWRI's Jubilee Seminars, which were held in 17 different locations around Australia: Melbourne, Bendigo, Mildura, Wodonga, Vic; Hobart, Launceston, Tas; Swan Valley, Margaret River, Mount Barker, WA; Hunter Valley, Griffith, Cowra, NSW: Canberra, ACT; Adelaide, Renmark, Coonawarra, SA; and Toowoomba, Qld. Details of the topics presented at these seminars can be found in Appendix 1.

A special edition of the *Australian Journal of Grape and Wine Research* Volume 11(2) was published as part of the commemoration of the AWRI's 50th anniversary. This issue contained exclusively AWRI staff members' review papers – details of which are contained in Appendix 6. These papers were reproduced with permission, along with other AWRI contributions, in a commemorative publication entitled *Advances in wine science – commemorating 50 years of The Australian Wine Research Institute*. This hard cover publication was provided to all jubilee seminar attendees and is now available for sale (details can be found on the AWRI website).

AWRI's Business Plan Towards 2015

The Group Manager assisted in the finalisation and production of the AWRI's Business Plan *Towards 2015*, an abridged version of the Plan and its Executive Summary. Details of this Business Plan were presented to the Grape and Wine Research and Development Board and to members of the Winemakers' Federation of Australia on 21 February 2006. Ten specific projects have emanated from the Plan:

1. Employer of choice
2. Seven-year costed research plan
3. Stakeholder communication and brand equity plan
4. Corporate governance
5. Review of AWRI's constitution
6. Expansion of commercial opportunities
7. Further development of the collaborative research network
8. Equipment replacement requirements
9. Risk management
10. Management development program

The objectives, strategies and details of these ten projects will be established by the end of 2006 and implemented as funding allows.

Date	Bulletin topic
8 July 2005	AWRI Agrochemicals booklet 2005/2006
8 August 2005	Boscalid MRL, Scala formulation
19 August 2005	Announcement of a single wine industry trade exhibition in 2007
28 September 2005	New fungicides and herbicides registered for viticulture, September 2005
4 November 2005	The use of Farmoz AXIOM MZ 720 for the control of Downy Mildew on grapevines
16 November 2005	Wine industry advice says 'no' to GMO
1 March 2006	AWBC alert for new wine taint (6-CC)
27 April 2006	AWRI Roadshow in Barossa Valley
9 May 2006	AWRI Roadshow in Langhorne Creek

Table 6. Email bulletins sent during 2005/2006.

Library catalogue databases	
AWRI_Database: Books, conference proceedings, theses, scientific and medical papers	52,798
JOURNALS: journals, newsletters, statistics and annual reports	412
Library information databases	
REGS: European Community wine legislation	406
ISYS – full text retrieval database covering	
United States of America Federal Register	879
Web accessible database 'Industry' *(with searchable abstracts)*	37,437
Web-accessible database 'Environment'	443

Table 7. Number of records on the Library's catalogue, information and web-accessible databases.

The members of the Communication and Information Services team dedicated significant time to the preparation of the budgets and submissions for the long-term funding agreement between the GWRDC and the AWRI. It is proposed that all of our current activities be retained and enhanced for the benefit of the Australian wine industry.

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 6). 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.

Media releases
Two media releases were prepared and distributed (1) 'Chief of world's largest wine company joins the Board of AWRI' was distributed on 15 December; and (2) 'AWRI Board is complemented with legal expertise from Foster's' was distributed on 16 March.

Wine Innovation Cluster (WIC)
During the year, the floor plans for WIC Central (AWRI's new home) were developed further, and a value management session was held with the consultants and stakeholders. The ability of AWRI to finance its share of the building was tested and confirmed.

Staff members directly involved with this process are:

WIC Steering Committee:
Sakkie Pretorius (Deputy: Rae Blair) and the following sub-committees reporting to the Steering Committee.

WIC Project Control Group:
Sakkie Pretorius, Holger Gockowiak

WIC Science Integration Committee:
Sakkie Pretorius, Markus Herderich

WIC Technical Reference Group:
Markus Herderich, Peter Godden, Rae Blair

The WIC *Project Charter* and *Agreement to lease* have been signed, and the WIC Central building is now planned for completion by April 2008.

Australian Wine Industry Technical Conference (AWITC)

Twelfth Australian Wine Industry Technical Conference
The Proceedings for the Twelfth Australian Wine Industry Technical Conference were completed and despatched to delegates in 2005. These proceedings are available for purchase via the AWITC website *www.awitc.com.au*.

AWITC website
The AWITC website has been completely redeveloped to improve its value to users and went live in May 2006. One of the features of the new website provides the ability of people participating in the conference, e.g. speakers, workshop convenors and poster authors, to submit their details on-line. On-line registration to the Thirteenth Australian Wine Industry Technical Conference will again be provided.

Thirteenth Australian Wine Industry Technical Conference
The planning for the Thirteenth Australian Wine Industry Technical Conference (to be held 29 July to 2 August 2007 in Adelaide) has commenced, and the registration brochure is planned for distribution in February 2007. The members of the Conference Planning Committee are:

South Australia
Sakkie Pretorius Chair, Conference Planning Committee C/- The Australian Wine Research Institute
Rae Blair Conference Manager
Kerry de Garis Stonehaven Winery
Chris Dundon FABAL
Richard Hamilton Foster's Wine Estates
Markus Herderich The Australian Wine Research Institute
Russell Johnstone Orlando-Wyndham Group
Louisa Rose The Yalumba Wine Company
Con Simos The Australian Wine Research Institute
Western Australia
Steve Partridge Agribusiness Research and Management
Queensland
Maryanne Pidcock Captain's Paddock
Victoria
Stephen Shelmerdine (resigned) Shelmerdine Vineyards
Australian Capital Territory
Frank van de Loo Mount Majura Wines
Tasmania
Andrew Hood Hood's Wines

Kate Beames is performing the Conference Secretariat's role again and Dr Eveline Bartowsky will manage the posters. Peter Godden and Con Simos will coordinate the workshop program and will be assisted by Narelle Cream (until she goes on maternity leave towards the end of 2006).

Australian wine industry members who participated on the Program Sub-Committee and were responsible for providing the direction of the program are:

Program Coordinators
Peter Godden,
The Australian Wine Research Institute
Richard Hamilton, Foster's Wine Estates
Markus Herderich,
The Australian Wine Research Institute
Russell Johnstone,
Orlando Wyndham Group Pty Ltd

ACT
Tony Battaglene,
Winemakers' Federation of Australia
Frank van de Loo, Mount Majura Wines

NSW
Malcolm Allen,
National Wine & Grape Industry Centre
Emma Grabham,
Winegrapes Marketing Board

Queensland
Rob Learmonth, Faculty of Sciences,
University of Southern Queensland
Maryanne Pidcock, Captain's Paddock

South Australia
Sue Bastian, School of Agriculture and Wine,
The University of Adelaide
Jim Caddy, CCW Co-operative Ltd , GWRDC,
Phylloxera Board
Steve Guy,
Australian Wine & Brandy Corporation
John Harvey, Grape & Wine Research &
Development Corporation
Paul Henry, Wine Australia
Sue Hodder, Wynns Coonawarra
Larry Lockshin, Division of Business, School
of Marketing, University of South Australia
Prue McMichael,
Scholefield Robinson Horticultural Services
Inca Pearce, Orlando Wyndham Group Pty Ltd
Sakkie Pretorius,
The Australian Wine Research Institute
Simon Robinson, CSIRO Plant Industry
Louisa Rose, The Yalumba Wine Company
Tony Royal, Portavin
Alex Sas, Hardy Wine Company
Elizabeth Waters,
The Australian Wine Research Institute

Tasmania
Duncan Farquhar, Department of Primary
Industries Water & Environment
Andrew Hood, Hood Wines

Victoria
Wendy Cameron,
Brown Brothers Milawa Vineyard Pty Ltd
Yasmin Chalmers,
Sunraysia Horticultural Centre
Greg Dunn, The University of Melbourne
Mark Krstic, Department of Natural
Resources & Environment
Rob Walker, CSIRO Plant Industry

Western Australia
Mark Gibberd, Centre for Wine Excellence
Tony Proffitt, AHA Viticulture

This group of people developed an exciting program commencing with an afternoon session on the Sunday, 29 July, and concluding with an afternoon session on the Wednesday, 1 August 2007. The workshop program and the colloquia are still under development and will be completed by October 2006. Invitations to local and international speakers in the formal program have been dispatched and are in the process of being confirmed.

Trade exhibition

The AWITC Inc. and the Wine Industry Suppliers' Association have entered into a cooperation agreement to co-present the AWITC's trade exhibition. This exhibition is conducted by Reed Exhibitions under licence from AWITC Inc. The exhibition is to be known as *WineTech – the Australian Wine Industry Trade Exhibition,* and will be held at the Adelaide Convention Centre from 29 July to 1 August 2007. It is anticipated that the entire available exhibition space at the Adelaide Convention Centre will be utilised in 2007 for the trade exhibitors from Australia and overseas. Unless the Centre expands its facility, and with modest growth projections anticipated for this event, it is likely that the Centre will not be able to accommodate this event in the future. We have commenced discussions with the Centre in this respect.

Analytical Service

Staff

Mai Nygaard, Randell Taylor, Sandra Lloyd-Davies, Matthew Cream, Oliver Lovat, Maria Mills, Jelena Jovanovic, Heather Brooks, David Boehm, Caroline Sarneckis, Stella Kassara (part time), Steve Smith, Carol Sigston, Danielle Leedham, Slavko Bekavac, Daniel Tynan, Danielle Butzbach.

2006 has been a very exciting year for the Analytical Service with solid growth in the number of analyses performed for the wine industry and significant milestones reached in the process of upgrading and streamlining of both the routine and trace laboratories to meet current and future analytical demands.

Some of the highlights for the 2005/2006 financial year were:

- Staff changes. New Group Manager, Mai Nygaard, appointed in November 2005. During 2006, a new position as Project Manager was established and 3 new staff members joined the analytical team.
- Automation of dry wine routine analysis through use of NATA accredited FTIR (FOSS, Winescan) and FIA (Lachat) methodology.
- Introduction of a new MCP tannin assay service for red grapes and dry reds based on a method developed by the AWRI R&D tannin team.
- Commissioning of a new GC-MS with SPME autosampler (Agilent)
- Implementation of method for the 6–chloro-orthocresol (6-CC) taint and provision for urgent analytical assistance to the wine industry
- Implementation of new LIMS (Laboratory Information Management System)
- Increased focus on communication with customers eg. through introduction of Analytical Service' industry newsletter 'The Wine Analyst' and active participation in industry seminars.

Background

The Analytical Service continues to serve a very broad range of customers in the Australian wine industry. In 2005/2006 more than 100,000 individual analysis were performed on a wide range of parameters. The Analytical Service keeps an updated list of services offered to the wine industry on our web page *www.awri.com.au/analytical_service.*

The Analytical Laboratory offer routine services including export certificates and upgrades to all major export markets, grape quality assessment analysis, a broad range of quality control and process management parameters on juices and wines as well as wine stability and sterility checks. The Trace Laboratory specialises in agrochemical residue analysis, aroma volatiles and taint analysis specifically targeted to meet the needs of the wine industry. In addition, Analytical Service offers wine sensory assessments by a trained panel, closure and taint investigations, as well as other project and contract work upon request.

The laboratory is NATA accredited and operates in accordance with ISO 17025, applying a strict quality management system. The laboratory is also GLP (Good Laboratory Practices) recognised in the field of analytical testing and grape processing for non-clinical residue studies. Throughout the year, the Analytical Service participated in a wide range of proficiency testing schemes (NATA, IWAG, DAPS, FAPAS) and performed consistently well in these inter laboratory comparison tests. An example is presented in Table 8 showing typical results obtained from a proficiency testing scheme round coordinated by IWAG (InterWinery Analysis Group)

The Z score explains the exact location of the original value within the distribution of data in the test and is assigned a number (+ or -) to inform of its position below or above the mean value. Z scores of < 2.0 are considered satisfactory.

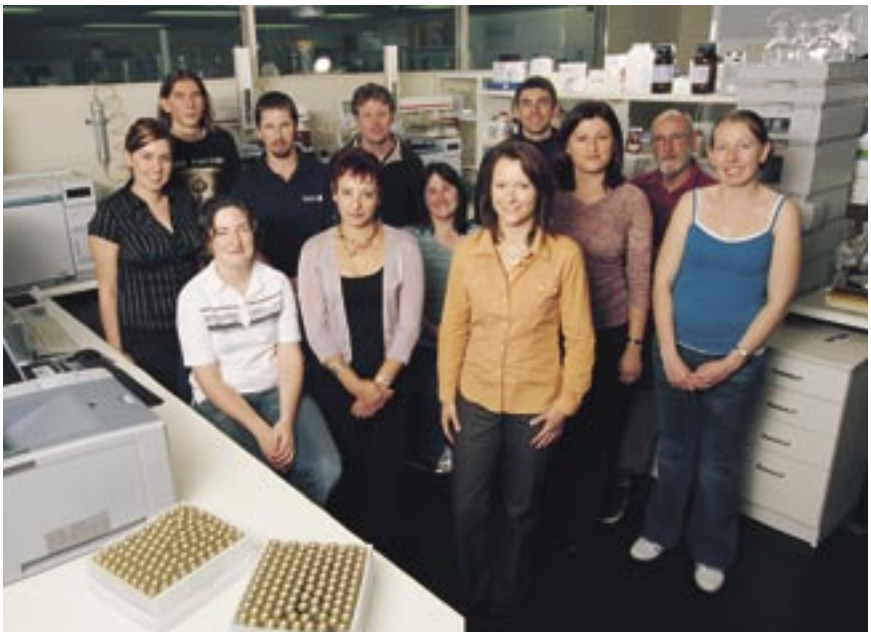
Staff changes

The previous Group Manager resigned in September 2005, and was replaced by Mai Nygaard in December 2005. Mai was previously employed by FOSS Analytical in Denmark where she was responsible for business development in the wine segment. Prior to this, Mai worked at Christian Hansen as Department Manager for Product Development and Application, Wine cultures, and she has more than ten years broad experience from the international wine industry.

Matthew Cream took up a new role as Project Manager in Analytical Service and spent most of 2006 as a full time resource on the very important LIMS project. Matthew had project assistance from a student, Oliver Lovat, on a 3-month work placement agreement, and in June 2006 Oliver joined the team full time. During a critical phase in the LIMS implementation (May-July 2006), Alan Pollnitz from Research was also seconded to Analytical Service as a part-time LIMS management resource.

The staff in the Analytical Laboratory also changed. January 2006, a new laboratory technician, Danielle Butzbach, was appointed. After the change in role of Matthew Cream, a new laboratory supervisor is sought while Heather Brooks from the Trace laboratory temporarily fills the position.

This year, the number of NATA signatories amongst staff has also been significantly increased.



Back Row: (left to right) *Caroline Sarneckis, Slavko Bekavac, Randell Taylor, Daniel Tynan, Heather Brooks, Matthew Cream, David Boehm.* ***Front Row:*** *Danielle Leedham, Maria Mills, Mai Nygaard, Jelena Jovanovic, Danielle Butzbach*

Analytical Laboratory

During the last year, significant instrument upgrades and new method validation and implementation were carried out in the Analytical Laboratory to continue to ensure timely and accurate results are supplied to our customers. Older equipment was replaced (UV/Vis spectrophotometer, cold stability bath) and new automated routine analysis such as FIA (Flow Injection Analysis) for free and total sulfur and FTIR for wine compositional analyses, were implemented.

Automation through FTIR (WineScan) and FIA

The WineScan was implemented into routine operation in February 2006. Prior to this, a series of validation reports were produced during a parallel testing period (Dec-Feb) showing a consistent performance on the analysis of dry wines. The AWRI dry wine calibration is NATA accredited for following parameters: alcohol, pH, TA, specific gravity, VA and glucose + fructose. The WineScan has in a short time become an essential part of the routine operation in the Analytical Laboratory. During the 2006 harvest, first validation of a grape juice calibration supplied by FOSS was carried out with the objective of implementing fast FTIR based juice analysis by next vintage.

The analysis of free and total sulfur in wine was also automated A method description and validation report for FIA (Flow injection analysis) was finalised in March and the new method 'Determination of sulfur dioxide in wine by Flow Injection analysis' was submitted to NATA, obtaining a successful accreditation in April. The main advantages of using the FIA method is fast, automated analysis with high precision, but the instrumentation has been requiring significant service and maintenance effort to ensure a stable operation and performance.

MCP tannin assay

Based upon a method developed by the Tannin Research Team, Analytical Service added a new MCP (Methyl Cellulose Precipitable) tannin assay service to the portfolio in April 2006. The method quantifies the amount of tannin (grape and oak derived) present in red grapes and wines, and can be used as a tool for the wineries to obtain better tannin management and better control of wine style. The assay is based on a UV-Vis measurement at abs 280 nm (for total phenolics). Samples are measured prior to and after precipitation of the tannins by methyl cellulose, and the change in absorbance is used to quantify the amount of tannin present in the sample. The MCP tannin assay can be performed on grape berry homogenate extracts (50% ethanol) or on young, dry wines.

Trace Laboratory

The Trace Laboratory continued to show an increase in the amount of analysis performed for most services offered. Oak aroma compounds and taint compounds (TCA, 6-CC) were in especially high demand in 2005/06. During the last year, the Trace Laboratory also expanded its major NATA accredited agrochemical residue assay and consolidated several other agrochemical analyses.

Increased capacity, GC/MS with SPME auto sampler for taint analysis

An Agilent 5975 GC/MS with a headspace SPME auto sampler was commissioned in December 2005 to meet the increasing industry demand for especially taint analysis. The new instrument provides the Trace laboratory with resources to develop new methods and provide efficient service with shorter turnaround times, especially in emergency responses such as smoke taints or the 6-CC type taints.

Analysis	Method	Sample A	Sample B	Z score A	Z score B
Free SO2 (mg/L)	Aspiration	19	19	-1	-1
Total SO2 (mg/L)	Aspiration	132	133	-0	0
pH	pH meter	3.41	3.40	0.6	0.4
Total acid (g/L)	Autotitrator	6.2	6.1	0.0	-0.5
Alcohol (% v/v)	NIR	14.1	14.0	-0.5	-1.0
Glucose+Fructose(g/L)	Enzymatic	3.8	3.9	-0.7	-0.3
Volatile acidity (g/L)	Distillation	0.37	0.35	0.14	-0.33
Malic acid (g/L)	Enzymatic	2.20	2.24	0.0	0.1
Citric acid (g/L)	Enzymatic	0.4	0.4	-0.83	0.67
Potassium	A. Absorption	641	640	0	0
Copper	A. Absorption	0.07	0.07	0.5	0.0
Iron	A. Absorption	0.8	0.7	0.3	0.0
Source: IWAG, statistical report, May 2006					

Table 8. Analytical data and corresponding z scores obtained by Analytical Service in a proficiency testing scheme round performed in May 2006 on a white wine sample (sample no. 06-03, presented as sample A and sample B).

6-CC and other taints

During February 2006, the wine industry experienced an unexpected taint problem related to the compound 6-chloro-orthocresol (6-CC). The timing of having added the extra GC/MS capacity to the Trace Laboratory was perfect. The Trace Laboratory managed to implement and cross-validate a new 6-CC method based upon a method and knowledge transfer from the Research Group. Routine analysis on yeast samples as well as wine samples was offered to the industry from the end of February onwards.

Currently, another related taint problem is being addressed by the Industry Development and Support team and the Analytical Service Trace laboratory and an additional method will be offered to the industry in August 2006.

LIMS

In recent years, Analytical Service have experienced increasing sample numbers and increased complexity of analysis, leading to higher demands for database system capacity and flexibility. The old Analytical Service database had become a seriously limiting factor and it was essential for the future operation and growth of the Analytical Service to change the platform to a new Laboratory Information Management System (LIMS). The implementation of the new LIMS (Labworks, Perkin Elmer) was a major milestone in 2006. The LIMS was chosen based on a set of criteria for functionalities required to optimise and automate laboratory work flows, secure sample and data management, quality management and documentation, as well as offering full traceability in the Analytical and Trace laboratories. After an initial customisation phase where the soft ware was redesigned to meet the specific requirements of the Analytical Service, the system functionality was tested and compared with the existing data base system prior to a 'go live' event in July 2006. The new system allows automated data capture, integrated quality control functionalities and optional features often requested by our customers, like electronic reporting and automated sample receipt notification. These additional features will be implemented as part of a second project phase planned for the last quarter of 2006.

General activities

The Analytical Service also assisted the wine industry with various contract work. These projects included an ongoing commercial closure trial, a survey for the AWBC and various projects for suppliers, consultants and other industry stakeholders.

The Analytical Service actively participated in industry seminars and activities like the InterWinery Analysis Group and launched an Analytical Service newsletter, 'The Wine Analyst' to keep our customers and stakeholders informed about major events and the latest in analytical services. The Analytical Service also sponsored the Best Riesling Trophy at the Royal Adelaide Wine Show in 2005 and continued our award-winning advertisement campaign developed by Geoffrey Reed Communications.

Outlook

The coming year will focus on further streamlining and development of the Analytical Service in order to meet the current and future industry needs. A main activity in 2006/2007 will be the preparation for moving the laboratories into the Wine Innovation Cluster Central building which will provide the Analytical Service with new state of the art laboratories and the necessary space and physical resources to ensure a healthy outlook for the Analytical Service.

Financial Report – Directors' report

Your Directors present their financial report for the year ended 30 June 2006.

Review of operations

The Australian Wine Research Institute (AWRI) was very pleased to have received a significant increase in funding from the Grape and Wine Research and Development Corporation (GWRDC) in the 2005-2006 year. The extra funding enabled the much needed revamping of a number of gas and liquid chromatographs, a modest increase in laboratory fermentation capacity, and most importantly, the acquisition of a state of the art mass spectrometer. These equipment enhancements have proved invaluable in the investigation and isolation of compounds contributing to a number of potentially significant industry taint problems that arose during the course of the year. In addition, the extra funding facilitated increased activity in a number of research projects associated with improving fermentation performance including the isolation of new yeast strains. The extra funding also facilitated the production and dissemination of a number of important industry publications, including the AWRI's commemorative booklet Advances in Wine Science, and the distribution of executive summaries of AWRI's Ten-year Business Plan and Seven-year Research, Development and Extension (RD&E) Plan to all levy payers.

The execution of a landmark multi-period investment agreement with the GWRDC will enable AWRI to consolidate its current level of RD&E activity and give our research staff more certainty in terms of employment tenure. AWRI is not immune from increasing international competition for high calibre researchers nor the increasing challenge to attract and retain such staff in the future. One strategic initiative undertaken in this regard has been the planning and progressive implementation of Human Resources policies and procedures to become regarded as an 'employer of choice'.

The pressing imperative to upgrade and expand AWRI's physical infrastructure has been progressed to the point where, following protracted negotiations, a 'Project Charter' and 'Agreement to Lease' have been entered into for the design, funding and construction of the Wine Innovation Cluster (WIC) Central building. The building will be built and owned by The University of Adelaide on the Waite Precinct and AWRI will enjoy a fifty-year tenancy. These documents were executed in July 2006. AWRI has committed $9.272 million of a projected building cost of approximately $30 million. AWRI will receive the benefit of $7.155 million of a total South Australian Government WIC grant of $9.5 million. The GWRDC, on behalf of industry, has committed $3.4 million. It is hoped that the building will be completed by mid 2008.

Results of operations

The increased funding level was supported by a 12% increase in Analytical Service revenue and increased revenue from other commercial activities. The reported profit figure reflects the necessary treatment of capital equipment funding as income and the derecognition of a number of what were essentially provisions as current liabilities. Impairment testing on non-current assets has resulted in a reduction of the value of the investment in Provisor from $650,000 to zero. The write down was based on the fact that AWRI is unable to receive any distribution of income from Provisor in the near future.

Significant changes in state of affairs

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

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 services.

Information on Directors

Directors of The Australian Wine Research Institute 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, 33 years of production and R&D experience in the Australian wine industry.	Chairman Member Executive Council	8	
James Frederick Brayne, BAppSc(Wine Science), Production Director/Chief Winemaker McWilliam's Wines Pty Ltd, National wine show judge, 33 years technical and winemaking experience in the Australian wine industry.		7	
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 15 years legal and management experience working in Australia, Asia, United Kingdom and United States. (from 2 May 2006)		2	
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, 28 years technical and winemaking experience in the Australian wine industry.	Member Audit Committee	7	1
Peter Francis Hayes, BSc, BAppSc(Wine Science), MS(Horticulture), DipEd, National Viticulturist, Southcorp Wines, past President, Australian Society of Viticulture and Oenology, Australia's representative on the OIV Viticulture commission and VineLink Association, Chair, CRC for Irrigation Futures, Board member, SA Wine and Brandy Industry Association, former Executive Director, GWRDC, 31 years research and development experience in the Australian wine industry. (to 31 December 2005)	Member Audit Committee	5	
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, Canberra and Cowra Wine Shows, Graduate of Melbourne University Advanced Management Program 1985, Member of ASVO Publishing Committee, 30 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), 33 years experience in the Australian wine industry.	Member Executive Council	7	
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. (from 10 February 2006)	Chair Audit Committee	3	1
Christopher Charles Steel, BSc(Hons), PhD, Associate Professor (Viticulture), Associate Head of School of Wine & Food Sciences and Faculty Sub-Dean (Graduate Training), Charles Sturt University, Editor *Plant Pathology,* 24 years research experience in plant protection, biochemistry and viticulture. (to 21 November 2005)		5	
Stephen Donald Tyerman, FAA BSc(Hons), PhD, Wine Industry Chair of Viticulture, The University of Adelaide, Associate Editor, *Journal of Experimental Botany,* Member of Editorial Advisory Committee, *Functional Plant Biology* and *The Plant Journal,* President of The Australian Society of Plant Scientists, 24 years plant physiology/horticultural research experience.	Member Executive Council	3	
Robert Ronald Walker, BAgSc(Hons) PhD, Program Leader, CSIRO Plant Industry, Program Manager, CRC for Viticulture, Editorial Panel Member, *Australian Journal of Grape and Wine Research,* Associate Editor, *Journal of Horticultural Science and Biotechnology,* Adjunct Professor, Charles Sturt University (Viticulture) and La Trobe University (Life Sciences), 25 years research management experience and 33 years research experience in horticulture and viticulture. (to 21 November 2005)		3	
Isak Stephanus Pretorius, BSc Agric(Hons) PhD, Managing Director, The Australian Wine Research Institute (from 27 August 2004), Professor Extraordinary in Oenology, University of Stellenbosch, Affiliate Professor in Oenology, University of Adelaide, Board Member, Provisor Pty Ltd, Committee 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,* 29 years experience in microbiology and biotechnology.	Member Executive Council	8	

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, committee member, Wine Industry Technical Advisory Committee, Board Member, Australian Wine and Brandy Corporation, 27 years winemaking experience in the Australian wine industry.			
Peter Ronald Dry, BAgSc, MAgSc, PhD, Associate Professor, School of Agriculture, Food and Wine, University of Adelaide, 36 years of academic and research experience in the Australian wine industry.			
Douglas James McWilliam, BSc, MSc (Food Science), past Chairman of Council, past Production Director, McWilliam's Wines Pty Ltd, member of CRCV II Board, 35 years production and R&D experience in the Australian wine industry. (to 5 December 2005)			
James Northey, BSc, Grad Dip (BusAdmin), Management Systems Manager, Hardy Wine Company, member of the South Australian Wine Industry Association Environment Committee, 25 years experience in the Australian wine industry.			
Andrew Mark Smith, MSc, PhD, National Grower Development Manager, Southcorp Wines, 9 years R&D management experience, 27 years research experience in agriculture, horticulture and viticulture. (to 31 December 2005)			
Alexander Nikolai Sas, BSc Agric(Hons), Regional Viticulturalist, Hardy Wine Company, 17 years experience in viticultural R&D and grape supply management.			
Anna Maria Grazyna Koltunow, BSc(Hons), PhD, Assistant Chief, CSIRO Plant Industry, Affiliate Professor, School of Agriculture and Wine, University of Adelaide (to 21 November 2005)		1	
Secretary			
Hans Englebert Muhlack BEc CPA			
Eight Meetings of the Board 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 14th day of November 2006.

R.E. Day
Chairman

I.S. Pretorius
Managing Director

INCOME STATEMENT
FOR THE YEAR ENDED 30 JUNE 2006

	Notes	2006 $	2005 $
Revenue from operating activities			
Grape and Wine Research and Development Corporation			
Project funds		6,690,174	5,147,995
Equipment		724,375	404,596
CRCV project funds		666,210	666,266
Commercial research collaborations		60,155	26,155
Analytical Service		1,974,426	1,761,163
Interest Income		242,868	173,214
Other revenue		499,591	415,842
Expenses from operating activities			
Employee benefit expense		6,112,514	5,257,556
Analytical and project operating expenses		1,659,489	1,199,822
Administration and general services expenses		861,158	662,842
Depreciation and amortisation expense	5	651,569	586,692
Travel expenses		175,753	204,797
Impairment write-down of investment in Provisor		650,000	0
Profit from ordinary activities		**747,316**	**683,522**
Total changes in equity		**747,316**	**683,522**

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

BALANCE SHEET
AS AT 30 JUNE 2006

	Notes	2006 $	2005 $
Current assets			
Cash assets		3,198,469	1,498,361
Commercial bills		2,558,181	2,411,922
Receivables	3	641,997	651,909
Other current assets	4	183,597	200,310
Total current assets		6,582,244	4,762,502
Non current assets			
Leasehold buildings	5	1,410,850	1,447,952
Plant and equipment	5	2,377,352	1,839,202
Investment in Provisor Pty Ltd	6	0	650,000
Australian Wine Industry Chair of Oenology		840,000	840,000
Total non current assets		4,628,202	4,777,154
TOTAL ASSETS		**11,210,446**	**9,539,656**
Current liabilities			
Payables and accruals	7	1,988,180	1,717,773
Project funds not expended and repayable			
GWRDC		746,488	242,840
CRCV		0	6,713
Provisions	8	898,333	818,019
Total current liabilities		3,633,001	2,785,345
Non current liabilities			
Provisions	8	193,348	117,530
Total non current liabilities		193,348	117,530
TOTAL LIABILITIES		**3,826,349**	**2,902,875**
NET ASSETS		**7,384,097**	**6,636,781**
EQUITY			
Reserves	9	700,000	700,000
Retained earnings	10	6,684,097	5,936,781
TOTAL EQUITY		**7,384,097**	**6,636,781**

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

STATEMENT OF CHANGES IN EQUITY FOR THE YEAR ENDED 30 JUNE 2006

	Retained Earnings $	Other Reserves $	Total $
As at 1 July 2004	**4,986,509**	**966,750**	**5,953,259**
Profit for the year	683,522	0	683,522
Total recognised income and expenses for the period	683,522	0	683,522
Transfer to retained earnings	266,750	(266,750)	0
As at 30 June 2005	**5,936,781**	**700,000**	**6,636,781**
Profit for the year	747,316	0	747,316
Total recognised income and expenses for the period	747,316	0	747,316
As at 30 June 2006	**6,684,097**	**700,000**	**7,384,097**

CASHFLOW STATEMENT FOR THE YEAR ENDED 30 JUNE 2006

	Notes	2006 $	2005 $
CASH FLOWS FROM OPERATING ACTIVITIES			
Grants and other income		10,642,864	8,065,020
Interest received		242,868	173,214
Payments to suppliers and employees		(7,884,027)	(7,164,195)
Net cash provided by operating activities	**11**	3,001,705	1,074,039
CASH FLOWS FROM INVESTING ACTIVITIES			
Payment for commercial bills		(145,259)	(398,485)
Payments for plant and equipment		(1,166,524)	(602,027)
Proceeds from sale of plant and equipment		11,186	12,818
Net cash used in investing activities		(1,301,597)	(987,694)
Net increase in cash held		1,700,108	86,345
Cash at 1 July		1,498,361	1,412,016
Cash at 30 June		3,198,469	1,498,361

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 (AWRI) was incorporated in South Australia in 1955. It is a company limited by guarantee without a share capital. It has been permitted to omit the word 'Limited' from its name.

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 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 14 November 2006.

First time adoption of International Financial Reporting Standards (AIFRS)

This is the first AIFRS financial report adopted by AWRI.

The adoption of AIFRS has not affected the reported financial position, financial performance or cash flows. Impairment testing on non current assets has resulted in a reduction in the asset value of the investment in Provisor from $650,000 to zero. The write down is based on the fact that AWRI is unable to receive any distribution from Provisor in the near future.

2. Statement of Accounting Policies

The financial report is a general purpose report and has been prepared in accordance with Australian Accounting Standards and the Corporations Act. 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. Items not received against a purchase order raised in the financial year are included in creditors to conform to the terms of the Institute's grant funding.

  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. Amounts in relation to funded non-current assets not received by 30 June, against purchase orders raised before the end of the financial year, are recognised as creditors to conform to the terms of the Institute's grant funding. 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.

	2006 $	2005 $
3. Receivables		
Trade debtors	440,530	542,304
Other debtors	201,467	109,605
	641,997	651,909
4. Other current assets		
Course materials	53,912	55,328
Prepayments	129,685	144,982
	183,597	200,310

5. Non current assets: amortisation and depreciation

	Leasehold buildings	Plant and equipment
Written down value		
Balance 30/06/2005	1,447,950	1,839,202
Additions	0	1,170,211
Disposals	0	17,592
Depreciation expense	37,100	614,469
Balance 30/06/2006	1,410,850	2,377,352

Proceeds on disposal of plant and equipment were $11,186 in 2006 and $12,818 in 2005.

Notes to and forming part of the Financial Report

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 AWRI. AWRI has completed its obligation to provide in kind support this year.

	2006 $	2005 $
7. Payables and accruals		
Trade creditors	1,569,229	877,744
PAYG and GST	191,449	243,726
Other creditors and accruals	227,502	596,303
	1,988,180	1,717,773
8. Provisions		
Current		
Employee entitlements	898,333	818,019
Non current		
Employee entitlements	193,348	117,530
Number of Employees (F.T.E.)	84.3	70.2
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	966,750
Transferred to retained earnings	0	(266,750)
Balance at the end of the year	700,000	700,000
10. Retained Earnings		
Balance at the beginning of the year	5,936,781	4,986,509
Transferred from capital reserve	0	266,750
Profit from ordinary activities	747,316	683,522
Retained earnings at the end of the year	6,684,097	5,936,781

	2006 $	2005 $
11. Reconcilliation of net cash provided by ordinary activities with ordinary profit		
Profit from ordinary activities	747,316	683,522
Non cash flows in operating profit		
Amortisation and depreciation	651,569	586,692
(Profit) loss on the sale of plant and equipment	2,823	3,285
Impairment of Provisor	650,000	
Charges to (reduction in) provisions	156,132	189,471
Changes in assets and liabilities		
(Increase) decrease in receivables and other current assets	26,524	(396,047)
Increase (decrease) in payables and accruals	767,341	7,116
Net cash provided by ordinary activities	3,001,705	1,074,039
12. Remuneration of key management personnel		
Key management personnel comprise directors and other persons having authority and responsibility for planning, directing and controlling the activities of AWRI		
Short-term employee benefits	782,271	773,015
Post-employment benefits	100,837	103,500
Termination benefits	0	0
Total	883,108	876,515
13. Remuneration of Auditors		
(a) For auditing the financial report	15,750	13,850
(b) For other services	17,309	6,095
	33,059	19,945

14. Directors holding office

The following directors held office during the year:

Directors	Alternate Directors
Robin Elliott Day	Leon Phillip Deans
Peter Francis Hayes	Andrew Mark Smith
Paul Conroy	
Stephen Brian Millar	
Timothy Wickham Bevan James	James Northey
Geoffrey Raymond Linton	Nigel Peter Blieschke
Christopher Charles Steele	
Robert Ronald Walker	Anna Maria Grazyna Koltunow
James Frederick Brayne	Douglas James McWilliam
Peter James Dawson	Alexander Nikolai Sas
Stephen Donald Tyerman	Peter Ronald Dry
Isak Stephanus Pretorius	

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

15. Related parties

Cooperative Research Centre for Viticulture (CRCV)

Australian Wine Industry Technical Conference Incorporated (AWITC)

Australian Society of Viticulture & Oenology Incorporated (ASVO)

Viticultural Publishing Incorporated

Provisor Pty Ltd

The AWRI 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.

	2006 $	2005 $
Transactions with Related Entities:		
Administrative services charged to:		
- ASVO	6,860	24,321
- AWITC	41,009	40,305
Funding received from the CRCV	666,210	666,266
Services received from AWITC	707	7,435
Services received from Provisor Pty Ltd	33,404	48,530
Services provided to Provisor Pty Ltd	35,432	30,265
Amount to be repaid to CRCV	0	6,713
Amount still to be paid by CRCV	15,475	0

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 45 to 51 are in accordance with the Corporations Act, comply with the accounting standards and give a true and fair view of the company's financial position as at 30 June 2006 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 14th day of November 2006.

Auditor Independence declaration

To the Directors of The Australian Wine Research Institute

As lead engagement partner for the audit of The Australian Wine Research Institute for the year ended 30 June 2006, 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 14th day of November 2006.

Independent Audit Report

TO MEMBERS OF THE AUSTRALIAN WINE RESEARCH INSTITUTE

Scope

The financial report and directors' responsibility

The financial report comprises the income statement, balance sheet, statement of changes in equity, cashflow statement, notes to and forming part of the financial report and the directors' declaration for The Australian Wine Research Institute for the year ended 30 June 2006.

The directors of the company are responsible for the preparation and true and fair presentation of the financial report in accordance with the Corporations Act 2001. This includes responsibility for the maintenance of adequate accounting records and internal controls that are designed to prevent and detect fraud and error and for the accounting policies and accounting estimates inherent in the financial report.

Audit approach

We conducted an independent audit in order to express an opinion to the members of the company. Our audit was conducted in accordance with Australian auditing standards in order to provide reasonable assurance as to whether the financial report is free of material misstatement. The nature of an audit is influenced by factors such as the use of professional judgement, selective testing, the inherent limitations of internal control and the availability of persuasive rather than conclusive evidence. Therefore, an audit cannot guarantee that all material misstatements have been detected.

We performed procedures to assess whether in all material respects the financial report presents fairly, in accordance with the Corporations Act 2001, including compliance with accounting standards and other mandatory financial reporting requirements in Australia, a view which is consistent with our understanding of the company's financial position and of its performance, as represented by the results of its operations and cash flows.

We formed our audit opinion on the basis of these procedures, which included:

- examining, on a test basis, information to provide evidence supporting the amounts and disclosures in the financial report; and
- assessing the appropriateness of the accounting policies and disclosures used and the reasonableness of significant accounting estimates made by the directors.

While we considered the effectiveness of management's internal controls over financial reporting when determining the nature and extent of our procedures, our audit was not designed to provide assurance on internal controls.

Independence

In conducting our audit, we followed applicable independence requirements of Australian professional ethical pronouncements and the Corporations Act 2001.

Audit opinion

In our opinion, the financial report of The Australian Wine Research Institute is in accordance with:

- (a) The Corporations Act 2001, including:
- (i) giving a true and fair view of the company's financial position as at 30 June 2006 and of its performance for the year ended on that date; and
- (ii) complying with accounting standards in Australia and the Corporations Regulations 2001; and
- (b) other mandatory financial reporting requirements in Australia.

PKF
A South Australian Partnership
Chartered Accountants

I.J. Painter
Partner

Signed at Adelaide this 14th day of November 2006.

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 the 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:

1. (a) The Income Statements give a true and fair view of each Trust's surplus for the year ended 30 June 2006;

   (b) The Balance Sheets give a true and fair view of each Trust's state of affairs as at 30 June 2006.

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 14th day of November 2006.

SURPLUS FOR THE YEAR	4,485	4,107	9,141	

BALANCE SHEETS	The John Fornachon Memorial Library Endowment Fund		The Thomas W Hardy Mer Trust	
As at 30 June 2006	**2006 $**	**2005 $**	**2006 $**	
Current Assets				
Cash at Bank	2	2	1	
Receivables	-	-	-	
Total Current Assets	**2**	**2**	**1**	
Non-Current Assets				
Investments	94,149	89,164	90,179	
TOTAL ASSETS	**94,151**	**89,166**	**90,180**	8
Current Liabilities				
Sundry creditors	940	440	950	
NET ASSETS	**93,211**	**88,726**	**89,230**	8
TRUST FUNDS				
Settled Sum	12,785	12,785	50	
Founder's Donation	-	-	25,000	
	12,785	12,785	25,050	
ACCUMULATED SURPLUS				
Opening balance	75,941	71,834	55,039	
Surplus for the year	4,485	4,107	9,141	
Closing balance	80,426	75,941	64,180	
TOTAL TRUST FUNDS	**93,211**	**88,726**	**89,230**	8

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 2006	**2006 $**	**2005 $**	**2006 $**	**2005 $**	**2006 $**	**2005 $**	**2006 $**	**2005 $**
Income								
Interest	4,985	4,562	4,641	3,948	3,258	2,985	4,903	4,553
Donations	-	-	5,000	5,000	-	-	-	-
	4,985	**4,562**	**9,641**	**8,948**	**3,258**	**2,985**	**4,903**	**4,553**
Expenditure								
Advertising	-	-	-	220	-	-	-	-
Audit fees	500	455	500	440	500	440	500	440
Bank charges	-	-	-	5	-	-	-	-
Sponsorship	-	-	-	-	-	-	2,890	-
	500	**455**	**500**	**665**	**500**	**440**	**3,390**	**440**

The accompanying notes form part of these 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 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 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 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 out weighs 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.

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 2006, as set out on pages 51 to 53. 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 2006 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 14th day of November 2006.

Appendix 1. External presentations and talks

Staff	Title of talk	Presented to and where	Date
P.A. Smith, E.G. Dennis, M.V. Perkins[1]	Synthesis and characterisation of A-type tannins	University of Mississippi, Oxford, Mississippi USA	1 July 05
D. Cozzolino, H.E. Smyth, K.A. Lattey, W.U. Cynkar, L. Janik, R.G. Dambergs, I.L. Francis, M. Gishen	Combining mass spectrometry based electronic nose, visible-near infrared spectroscopy and chemometrics to assess the sensory properties of Australian Riesling wines	*InVino Analytica Scientia,* Montpellier France	7 Jul 05
Y. Hayasaka	Can electrospray mass spectrometry help us to differentiate grape varieties?		
E.J. Waters	The effect of ascorbic acid, closure type and storage conditions on the composition, colour and flavour properties of a Riesling and wooded Chardonnay wine		
P.A. Smith, E.G. Dennis, M.V. Perkins[1], M.J. Herderich	An AWRI overview; wine phenolics overview; and synthesis and characterisation of A-type tannins	University of Cambridge, Cambridge, UK	12 July 05
P.A. Henschke, J.R. Bellon, J.M. Eglinton, K.S. Howell, T.E. Seibert, A. Soden, J.H. Swiegers, C.A. Varela, G.H. Fleet[2], I.L. Francis, P.J. Chambers, M.A. de Barros Lopes[3], I.S. Pretorius	Chasing the wine bouquet – new roles for yeast	38th Annual AIFST Convention, Darling Harbour, Sydney NSW	13 Jul 05
K.A. Lattey	Consumer preference -the ultimate quality test	CRCV Talking Technology, Adelaide SA	19 Jul 05
I.L. Francis and H.E. Smyth	Determining wine aroma from compositional data		
I.S. Pretorius	Flavour-active yeast: the evidence is in the wine glass	XIth International Congress of Mycology, San Francisco, USA	25 Jul 05
I.S. Pretorius	The Australian Wine Research Institute	AWRI 50th Anniversary Seminar, Gemini Hotel and Function Centre, Griffith NSW	8 Aug 05
P.W. Godden, M. Gishen, A.D. Coulter	Trends in the composition of Australian wine		
Y. Hayasaka, G.A. Baldock, A.P. Pollnitz	Application of mass spectrometry		
D. Cozzolino	Grape and wine analysis : chemometrics		
I.S. Pretorius	Development of flavour-active yeast		
I.L. Francis	Wine flavour		
D. Capone, R. Simpson, A.P. Pollnitz, G.K. Skouroumounis, K.H. Pardon, P. Howland[4], D. Barker[4], H. McLean[5], Mark Sefton	Transfer of taint from natural cork closures		
S.-J. Bell, P.A. Henschke	Implications of nitrogen for grapes and wine		
R.J. Blair	Accessing information from the AWRI		
P.A. Smith	Chemistry careers	Flinders University, Adelaide SA	11 Aug 05
M.J. Herderich	The 'Tannin Project' (CRCV 1.2): Research outcomes & future directions	CRCV Industry Reference Group, Adelaide SA	12 Aug 05
D. Cozzolino, W.U. Cynkar, R.G. Dambergs, M. Gishen, L. Janik	Rapid instrumental methods – past success and future potential	CRCV Industry Reference Group presentation, Adelaide SA	12 Aug 05
R.G. Dambergs, W.U. Cynkar, L. Janik, D. Cozzolino, M. Gishen.	Commercial wine quality grading – correlations with spectral properties	CRCV 'Talking Technology' Symposium, Objective measurement of grape quality, Adelaide SA	19 Jul 05
D.Cozzolino, B. Dambergs, W. Cynkar, L. Janik and M. Gishen	Advances in spectroscopy related to grape and wine analysis	Orlando Wyndham Group winemakers and viticulturists, Rowland Flat SA	19 Aug 05
P.A. Smith	The AWRI: an overview	Belair Country Club, Flinders University Nanostructures and Molecular Interactions group meeting, Belair SA.	20 Aug 05

1 Flinders University, 2 University of New South Wales, 3 University of South Australia, 4 The University of Adelaide – School of Agriculture and Wine, 5 Orlando Wines, 6 Lallemand Australia, 7 John Field Consulting Pty Ltd, 8 Currently at the Australian Research Council, 9 The University of Adelaide - School of Chemical Engineering, 10 Patrick Iland Wine Promotions, 11 CSIRO Health Science and Nutrition, 12 The Alfred/Monash University, 13 University of Western Australia, 14 Currently at the Yalumba Wine Company, 15 Consultant, UK, 16 Hardy Wine Company, 17 Provisor, 18 University of Stellenbosch, 19 Mauri Yeast, 20 Victoria University, 21 The University of Adelaide – School of Electrical and Electronic Engineering, 22 Berri Estates Winery, 23 McGuigan Simeon Wines, 24 Pontificia Universite Católica de Chile, 25 University of Melbourne

Staff	Title of talk	Presented to and where	Date
R.E. Day, I.S. Pretorius	The Australian Wine Research Institute	AWRI 50th Anniversary Seminars: Moorilla Estate, Berriedale Tas	23 Aug 05
C.S. Stockley	Better wine for better health		
Y. Hayasaka, G.A. Baldock, A.P. Pollnitz	Application of mass spectrometry	Providence Vineyards, Lalla Tas	24 Aug 05
P.W. Godden, M. Gishen	Trends in the composition of Australian wine		
D. Capone, R. Simpson, A.P. Pollnitz, G.K. Skouroumounis, K.H. Pardon, P. Howland[4], D. Barker[4], H. McLean[5], Mark Sefton	The transfer of taint from natural cork closures		
I.S. Pretorius	Development of flavour-active yeast		
C.D. Curtin, J.R. Bellon, D. Capone, P.J. Costello[6], A.D. Coulter, G. Cowey, D. Cozzolino, J.B. Field[7], M. Gishen, P. Graves, P.A. Henschke, K.A. Lattey, E. Robinson, P.B. Høj[8], I.L. Francis, M.A. de Barros Lopes[3], P.W. Godden	*Brettanomyces* and red wine in Australia		
I.L. Francis	Wine flavour		
R.J. Blair	Accessing information from the AWRI		
I.S. Pretorius	The Australian Wine Research Institute	AWRI 50th Anniversary Seminars: Hunter Valley Gardens, Pokolbin NSW	12 Sep 05
P.W. Godden, M. Gishen	Trends in the composition of Australian wine		
R.G. Dambergs	Grape and wine analysis: chemometrics	Australian Catholic University, Watson ACT	13 Sep 05
D. Capone, R. Simpson, A.P. Pollnitz, G.K. Skouroumounis, K.H. Pardon, P. Howland[4], D. Barker[4], H. McLean[5], Mark Sefton	Transfer of taint from natural cork closures	J.T. Pridham Conference Centre, Cowra Agricultural Research & Advisory Centre, Cowra NSW	14 Sep 05
P.J. Chambers	The genetics of olfaction and taste		
S.-J. Bell and P.A. Henschke	Implications of nitrogen for grapes and wine		
E.J. Waters, G. Alexander[4], R. Muhlack[9], K.F. Pocock, C.B. Colby[9], B. O'Neill[9], P.B. Høj[8], P. Jones	Preventing protein haze in bottled white wine		
I.S. Pretorius	Development of flavour-active yeast		
R.J. Blair	Accessing information from the AWRI		
C.S. Stockley	Our operating environment: a comparison of WHO and individuals countries' policies on alcohol and hence wine consumption	Vindaba 2005 International Wine and Health Conference, Stellenbosch South Africa	14 Sep 05
S-J. Bell	Nitrogen from vineyard to wine	Hardy Wines Grower Meeting, Clare Valley	20 Sep 05
I.S. Pretorius	AWRI and its contribution to the Australian wine industry	Wine Industry Supplier's Australia (WISA) Annual General Meeting, National Wine Centre, Adelaide SA	21 Sept 05
E.J. Waters	Wine development in bottle – impact of closures, storage conditions and ascorbic acid addition	Rutherglen Wine Show Seminar	22 Sep 05
R.G. Dambergs, D. Cozzolino, W.U. Cynkar, L. Janik, M. Gishen	The relationship of grape and wine colour with quality	*Growing great grapes* Seminar, King Valley Vignerons, King Valley Vic	3 Oct 05
P.A. Smith, C.J. Sarneckis, P. Jones, B. Kambouris[23], R.G. Dambergs, M.J Herderich	A mouthful; measuring tannins in grapes and red wines		

1 Flinders University, 2 University of New South Wales, 3 University of South Australia, 4 The University of Adelaide – School of Agriculture and Wine, 5 Orlando Wines, 6 Lallemand Australia, 7 John Field Consulting Pty Ltd, 8 Currently at the Australian Research Council, 9 The University of Adelaide - School of Chemical Engineering, 10 Patrick Iland Wine Promotions, 11 CSIRO Health Science and Nutrition, 12 The Alfred/Monash University, 13 University of Western Australia, 14 Currently at the Yalumba Wine Company, 15 Consultant, UK, 16 Hardy Wine Company, 17 Provisor, 18 University of Stellenbosch, 19 Mauri Yeast, 20 Victoria University, 21 The University of Adelaide – School of Electrical and Electronic Engineering, 22 Berri Estates Winery, 23 McGuigan Simeon Wines, 24 Pontificia Universite Católica de Chile, 25 University of Melbourne

Appendix 1. External presentations and talks

Staff	Title of talk	Presented to and where	Date
P.A. Smith, C.J. Sarneckis, P. Jones, R.G. Dambergs, M.J Herderich	Development and application of a simple and robust assay for measuring tannins	ASVO Advances in tannin and tannin management seminar, Adelaide Convention Centre, Adelaide, SA	6 Oct 05
M.J. Herderich, M. Birse, R.G. Dambergs, H. Holt, P. Iland[10], K. Lattey, M. Parker, P. Smith	Grape and wine tannins: an overview on current research, emerging applications and future challenges		
C.S. Stockley, W. Greenrod[11], M. Abbey[11]	Background diet influences markers of risk for cardiovascular disease after moderate wine consumption	Second International Conference on Polyphenols and Health, University of California Davis, CA USA	6 Oct 05
I.S. Pretorius	The Australian Wine Research Institute	AWRI 50th Anniversary Seminar, Chardonnay Lodge, Coonawarra SA	11 Oct 05
P.W. Godden, M. Gishen	Trends in the composition of Australian wine		
D. Cozzolino	Grape and wine analysis: chemometrics		
E.J. Waters, G. Alexander[4], R. Muhlack[9] K.F. Pocock, C. Colby[9], B. O'Neill[9], P.B. Høj[8], P. Jones	Preventing protein haze in bottled white wine		
E.J. Bartowsky	*Oenococcus oeni* and MLF: moving into the molecular arena		
M.J. Herderich, P.A. Smith	Analysis of grape and wine tannins		
I.S. Pretorius	Development of flavour-active yeast		
I.L. Francis	Wine flavour		
R.J. Blair	Accessing information from the AWRI		
C.S. Stockley	Wine and health research in Australia past, present and future	National Centre for Wine and Cardiovascular Health, University of Alabama , Birmingham, Alabama USA	11 Oct 05
S-J. Bell	All bottled up: what can you do in the vineyard to affect flavour in the bottle?	Some Like it Hot, Renmark SA	13 Oct 05
M.J. Herderich	From grapes to glass: cracking the code of wine composition and flavour	Food Chemistry – link between Chemistry, Biology and Medicine, International Conference, University Würzburg, Germany	14 Oct 05
A. Pollnitz	Aroma and flavour research at The Australian Wine Research Institute	Science Industry Australia Science Commercialisation Symposium, Adelaide SA	18 Oct 05
M.J. Herderich	AWRI Research – an overview	LVWO Weinsberg, Germany	19 Oct 05
P.A. Smith	Delivering the goods; what factors generate perceptions of quality	Winedown 05, National Wine Centre, Adelaide SA	24 and 25 Oct 05
I.S. Pretorius	Naturally better		
J.H. Swiegers	Flavour-active wine yeast		
I.S. Pretorius	Naturally better		
P.A. Smith, M. Mercurio, C.J. Sarneckis, R.G. Dambergs, M.J. Herderich	MCPT Assay: quantitation of tannins in HWC grape and wine samples	Hardy Wine Company Technical Project Meeting, Reynella SA	26 Oct 05
J.H. Swiegers	Flavour-active wine yeast		
J.H. Swiegers	Flavour-active wine yeast	Anchor Bio-Technologies Ninth Technical Symposium, Stellenbosch South Africa	1 Nov 05
M.J. Herderich	Overview of AWRI Research	CSIRO Food Futures Flagship Workshop, Adelaide SA	1 Nov 05
I.S. Pretorius	The Australian Wine Research Institute	AWRI 50th Anniversary Seminar, Grand Mildura Hotel, Mildura Vic	3 Nov 05
P.W. Godden, M. Gishen, G.D. Cowey	Trends in the composition of Australian wine		
M.J. Herderich	Analysis of grape and wine tannins		
S.-J. Bell and P.A. Henschke	Implications of nitrogen nutrition for grapes, fermentation and wine		

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Staff	Title of talk	Presented to and where	Date
D. Capone, R. Simpson, A.P. Pollnitz, G.K. Skouroumounis, K.H. Pardon, P. Howland[4], D. Barker[4], H. McLean[5], M.A. Sefton	Transfer of taint from natural cork closures	AWRI 50th Anniversary Seminar, Grand Mildura Hotel, Mildura Vic	3 Nov 05
I.S. Pretorius	Development of flavour-active yeast		
I.L. Francis	Wine flavour		
R.J. Blair	Accessing information from the AWRI		
C.D. Curtin, G.D. Cowey	Update on *Dekkera/Brettanomyces* project	Fosters red winemaking group, Wolf Blass Winery, Nutriootpa SA	5 Nov 05
R.G. Dambergs	Welcome and introduction	AWRI Roadshow Seminar, Comfort Inn Gemini, Griffith NSW	8 Nov 05
C.D. Curtin	The AWRI *Brettanomyces* research trial		
R.G. Dambergs	Commercial wine quality grading – correlations with spectral properties (ex AWITC)		
E.J. Bartowsky, P.A. Henschke	Flavour aspects of MLF – control of the 'buttery' diacetyl character in wine		
G.K. Skouroumounis	White wine aging: the role of ascorbic acid, and bottle storage conditions		
M.G. Holdstock	Update on the AWRI trial of the technical performance of wine closures		
P.A. Henschke, P.J. Costello[6], P.R. Grbin[4]	Causes and control of mousy off-flavour in wine		
S.-J. Bell	Manipulation of phenolic profiles in red grapes and wine by viticultural management		
G.K. Skouroumounis	Impact of ullage volume under screw cap (ROTE) on chemical composition and sensory properties of a Cabernet Sauvignon wine		
R.G. Dambergs	Welcome and introduction	AWRI Roadshow Seminar, Sunraysia Horticultural Centre, Irymple Vic	9 Nov 05
C.D. Curtin	Strategies for the control of *Dekerra/ Brettanomyces* during winemaking		
G.K. Skouroumounis	Impact of ullage volume under screw cap (ROTE) on chemical composition and sensory properties of a Cabernet Sauvignon wine		
R.G. Dambergs	Commercial wine quality grading – correlations with spectral qualities		
G.K. Skouroumounis	White wine aging: the role of ascorbic acid, and bottle storage conditions		
J.M. Eglinton, P.A. Henschke	Origin of volatile acidity in fermentation and its role in re-starting stuck fermentation		
M.G. Holdstock	Update on the AWRI trial of the technical performance of wine closures		
S-J. Bell	Preventing protein haze in bottled white wine		
P.A. Henschke, P.J. Costello[6], P.R. Grbin[4]	Causes and control of mousy off-flavour in wine		
S-J. Bell	Agrochemicals: selling quality wine		
C.D. Curtin	The AWRI *Brettanomyces* research trial		
R.G. Dambergs	Development and application of a simple and robust assay for quantitation of tannins in grape and wine samples		
M.J. Herderich	Cracking the codes of wine composition and quality: an overview of research at The Australian Wine Research Institute	Frontiers in Biomedical and Material Sciences Seminar, Flinders University, Adelaide SA	9 Nov 05

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Staff	Title of talk	Presented to and where	Date
R.G. Dambergs	Welcome and introduction	AWRI Roadshow Seminar, Renmark Hotel Function Centre, Riverland SA	10 Nov 05
C.D. Curtin	The AWRI *Brettanomyces* research trial		
G.K. Skouroumounis	Impact of ullage volume under screw cap (ROTE) on chemical composition and sensory properties of a Cabernet Sauvignon wine		
E.J. Bartowsky, P.A. Henschke	Flavour aspects of MLF – control of the 'buttery' diacetyl character in wine		
S.-J. Bell	Preventing protein haze in bottled wine		
G.K. Skouroumounis	White wine aging: the role of ascorbic acid, and bottle storage conditions		
J.M. Eglinton, P.A. Henschke	Origin of volatile acidity in fermentation and its role in re-starting stuck fermentation		
M.G. Holdstock	Update on the AWRI trial of the technical performance of wine closures		
S.-J. Bell	Grape maturity tannins: the impact of viticultural treatments on grape and wine tannins		
P.A. Henschke, P.J. Costello[6], P.R. Grbin[4]	Causes and control of mousy off-flavour in wine		
S.-J. Bell	Agrochemical issues for grape growers and winemakers		
C.D. Curtin	Strategies for the control of *Dekerra/ Brettanomyces* during winemaking		
R.G. Dambergs	Development and application of a simple and robust assay for quantitation of tannins in grape and wine samples		
J.H. Swiegers	Flavour-active wine yeast	Fosters Wine Estates Technical Symposium, Wolf Blass, Barossa Valley SA	22 Nov 05
I.S. Pretorius	The Australian Wine Research Institute	AWRI 50th Anniversary Seminars: Emerald Colonial Lodge, Margaret River WA	22 Nov 05
P.W. Godden, M. Gishen, A.D. Coulter	Trends in the composition of Australian wine		
C.S. Stockley	Better wine for better health	Goundrey Wines, Mount Barker WA	23 Nov 05
S.-J. Bell and P.A. Henschke	Implications of nitrogen for grapes and wine		
E.J. Bartowsky	*Oenococcus oeni* and MLF: moving into the molecular arena	Sandalford Caversham Estate, Caversham WA	24 Nov 05
M.J. Herderich	Analysis of grape and wine tannins		
I.S. Pretorius	Development of flavour-active yeast		
I.L. Francis	Wine flavour		
R.J. Blair	Accessing information from the AWRI		
M.A. Sefton	Compounds causing cork taint and the factors affecting their transfer from natural cork closures to wine	International conference 'Off-flavours in wine and other beverages: origin, detection and control', Tarragona Spain	23 Nov 05
M.J. Cream	Yeast assimilable nitrogen	Interwinery Analysis Group Annual Review Seminar, Mildura Vic	25 Nov 05
I.S. Pretorius	The Australian Wine Research Institute	AWRI 50th Anniversary Seminar, University of Southern Queensland, Toowoomba Qld	29 Nov 05
C.S. Stockley	Better wine for better health		
Y. Hayasaka, G.A. Baldock, A.P. Pollnitz	Application of mass spectrometry		
E.J. Bartowsky	*Oenococcus oeni* and MLF: moving into the molecular arena		
M.J. Herderich, P.A. Smith	Analysis of grape and wine tannins		
R.G. Dambergs	Grape and wine analysis: chemometrics		
I.S. Pretorius	Development of flavour-active yeast		

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Staff	Title of talk	Presented to and where	Date
P.J. Chambers	The genetics of olfaction and taste	AWRI 50th Anniversary Seminar, University of Southern Queensland, Toowoomba Qld	29 Nov 05
A.D. Coulter	Trouble free winemaking - the identification, avoidance and management of common wine instabilities	Hunter Valley Winemakers Association seminar, Hunter Valley NSW	30 Nov 05
G.D. Cowey	Update of the AWRI *Brettanomyces* project HPLC analysis of *Brettanomyces*-derived spoilage compounds and their precursors Tasting of commercial wines displaying varying degrees of *Brettanomyces*-derived sensory characters	Fosters Wine Group Technical Meeting, Barossa Valley SA	1 Dec 05
C.D. Curtin	Genetic diversity of *Dekkera* isolates from Australian wine and their distribution Physiological characterisation of Australian *Dekkera* strains		
R.C. Brown	The synthesis and aroma properties of optically pure oak lactones	16th Annual Adelaide Organic Symposium, Adelaide SA	6 Dec 05
J.R. Bellon	Interspecific hybrids of *Saccharomyces cerevisiae*	Department of Genetics, Stanford University, USA	17 Jan 06
P.W. Godden	Welcome and introduction	AWRI Roadshow Seminars:	
R.G. Dambergs	Grape colour – why is it important and how can it be measured?	Lands Building, Hobart Tas	17 Jan 06
P.A. Henschke, P.W. Godden	Understanding and avoiding sub-optimal fermentation	TAFE Tasmania, Newnham Tas	18 Jan 06
A.P. Pollnitz	White wine ageing: the role of ascorbic acid, and bottle storage conditions		
S.-J. Bell	Manipulation of phenolics profiles in red grapes and wine by viticultural management		
K.A. Lattey	Major influences on red wine mouth-feel		
P.W. Godden	Results from the AWRI *Brettanomyces* research project: survey data on the incidence of *Brettanomyces* spoilage in Australian wine; the genetic diversity and morphological differences between *Dekkera/Brettanomyces* strains isolated from Australian wineries; and review of winery applicable detection methods		
A.P. Pollnitz	The ability of various wine bottle closures and fining agents to remove flavour and aroma compounds from wine		
S.-J. Bell	Managing *Botrytis* in the vineyard		
R.J. Blair, P.W. Godden	Accessing information from the AWRI		
K.A. Lattey	Practical methods for wine sensory analysis		
P.J. Costello[6], H. Gockowiak, P.A. Henschke	Strategies for successful induction of malolactic fermentation	*Additional presentations:* AWRI Roadshow Seminar, TAFE Tasmania, Newnham Tas	18 Jan 06
R.G. Dambergs	Development and application of a simple and robust assay for quantitation of tannins in grape and wine samples		
P.W. Godden	Trouble free winemaking – the identification, avoidance and management of common wine instabilities – including *Brettanomyces*	AWRI Roadshow workshop: Trouble free winemaking: managing wine instabilities, understanding and managing nitrogen and identifying wine faults, TAFE Tasmania, Newnham Tas	19 Jan 06
G.D. Cowey	Simulated faulty wine tasting		
M.G. Holdstock	Use of the AWRI Website		
P.A. Henschke	Optimal nitrogen for optimal fermentation		

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Staff	Title of talk	Presented to and where	Date
M.G. Holdstock	YAN measurement made easy	AWRI Roadshow workshop: Trouble free winemaking: managing wine instabilities, understanding and managing nitrogen and identifying wine faults, TAFE Tasmania, Newnham Tas	19 Jan 06
G.D. Cowey	A diagnostic test for reductive wine characters		
G.D. Cowey	Factors related to the development of 'reductive' characters in wine after bottling		
E.J. Bartowsky	MLF and wine associated bacteria	Masters of Wine, Melbourne, Vic	21 Jan 06
M. Gishen	Quality management systems	Yalumba contractors' pre-vintage workshop, Yalumba winery, Angaston SA	1 Feb 06
P.W. Godden	The avoidance of taints and chemical instabilities during winemaking – case studies from the AWRI's problem solving and investigative service		
I.L. Francis, J.H. Swiegers, K.A. Lattey, B.R. Bramley, R. Willmott, M.J. Herderich, I.S. Pretorius	The influence of yeast strain on Sauvignon Blanc aroma	Sixth International Cool Climate Symposium for Viticulture and Oenology, Christchurch, New Zealand	6 Feb 06
I.L. Francis, K.A. Lattey and B.R. Bramley	Do consumers like cool climate wines?		10 Feb 06
I.S. Pretorius	Closing and unifying remarks		
I.S. Pretorius	Presentation of AWRI's Business Plan *Towards 2015*	GWRDC Board and representatives from WFA and WGGA, Stamford Grand, Glenelg SA	21 Feb 06
S-J. Bell	Downy Mildew Spray Trial Outcomes	Riverland Wine Industry and Development Council, Loxton SA	25 Feb 06
I.S. Pretorius	Science collaboration in the Wine Innovation Cluster (WIC)	WIC Workshop, Waite Campus, Urrbrae SA	28 Feb 06
D. Cozzolino, R.G. Dambergs, W.U. Cynkar, L. Janik, M. Gishen	Application of spectroscopy and chemometrics in the wine industry	CSIRO Entomology, Canberra ACT	9 Mar 06
C.S. Stockley, R. O'Hehir[12] and J. Rolland[12]	Double-blind placebo-controlled clinical trial of fined wines in subjects with confirmed sensitivity to eggs, fish, milk or nuts	OIV Wine, Health and Nutrition Subcommission meeting, Paris France	10 Mar 06
I.S. Pretorius	The AWRI research model	Sicilian business delegation, AWRI, Urrbrae SA	21 Mar 06
M. Nygaard	Analytical Services for the wine industry		
M. Mercurio, C.J. Sarneckis, R.G. Dambergs, M.J. Herderich, P.A. Smith	Quantitation of tannins: methyl cellulose precipitable tannin assay (MCPT assay)	Stonehaven Winery, Padthaway SA	28 Mar 06
I.S. Pretorius	Presentation of AWRI's Business Plan *Towards 2015*	WFA Board meeting, Canberra ACT	30 Mar 06
S-J. Bell	Agrochemical issues – selling quality wine	EE Muir and Sons Agronomist and Resellers Annual Seminar Day, Adelaide SA	3 Apr 06
	Phosphorous acid and wines for export		
	Agrochemicals – other issues		
I.S. Pretorius	Emerging development and patterns of microbes in wines (Chair of session)	International Wine Microbiology Symposium, California USA	4 Apr 06
I.S. Pretorius	Setting new goals for the design of improved wine yeast for a market directed wine industry	International Wine Microbiology Symposium, California USA	5 Apr 06
I.L Francis, B.R. Bramley, K.A. Lattey, T. Robinson[13], J. Considine[13]	Chardonnay wine aroma – site related variation within the Margaret River region	Agricultural Research Western Australia Viticulture and Oenology Research Forum, Cowaramup WA	5 May 06
P.W. Godden	Welcome and introduction	AWRI Roadshow seminar, Murray Institute of TAFE, Nuriootpa SA	5 May 06
J.H. Swiegers, I.L. Francis, I.S. Pretorius, P.J. Chambers	An essential role for yeast in the evolution of varietal flavour		
C.D. Curtin	Results of the AWRI *Brettanomyces* research project: survey data on the incidence of *Brettanomyces* spoilage in Australian wine, and the genetic diversity and morphological differences between *Dekkera/Brettanomyces* strains isolated from Australian wineries; and review of winery applicable detection methods		

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Staff	Title of talk	Presented to and where	Date
E.J. Waters	Development of new technologies for the prevention of protein haze formation in white wine: a progress report	AWRI Roadshow seminar, Murray Institute of TAFE, Nuriootpa SA	5 May 06
S.-J. Bell	Salty wine		
E.J. Bartowsky, P.J. Costello[6], H. Gockowiak, P.A. Henschke	Strategies for successful induction of malolactic fermentation		
P.J. Chambers	Issues relating to GMOs and how they affect the Australian wine industry		
P.A. Smith	Grape and wine tannins: an overview on current research emerging applications and future challenges.		
S.-J. Bell	Manipulation of phenolic profiles in red grapes and wine by viticultural management		
P.J. Chambers	Development of low alcohol yeast – progress report		
E.J. Bartowsky, S. Dillon[14], J. McCarthy, J Henschke	Potential for fermentation yeast and bacteria to modify red wine colour and flavour – results from recent laboratory and pilot scale experiments		
P.A. Smith	An industry survey of grape colour, tannin, TSS (Brix and crop yield) – with some implications for winemaking		
P.W. Godden	Strategies for the control of *Dekkera/ Brettanomyces* during winemaking		
D. Cozzolino, G. Cowey, K.A. Lattey, P.W. Godden, R.G. Dambergs, W.U. Cynkar, L. Janik, M. Gishen	Challenging the NIR spectra prediction of sensory panel response	Australian Near Infrared Group, Rockhampton Qld	9 May 06
M. Nygaard	Implementation of FTIR in a routine laboratory	FOSS Directions 2006 Seminar, Yeppoon QLD	10 May 06
I.S. Pretorius	The AWRI	Rotary Club of Adelaide West, Adelaide SA	11 May 06
S-J. Bell	Changes in the 2006/2007 Dog Booklet	Annual Agrochemical Reference Group Meeting, Petaluma, Crafers SA	16 May 06
	Phosphorous acid and wines for export		
R. Harding[15], C.S. Stockley	Communicating through government agencies	Symposium on moderate alcohol consumption, health risks and benefits, Institute on Lifestyle and Health, Boston University School of Medicine, Boston, MA USA	18 May 06
O.J. Macintyre	Production of a yeast haze protective manno-protein for sensory studies in white wine	Macrowine 2006, Reims, France	18 May 06
E.J. Waters	Grape PR proteins: are they just a nuisance to the winemaker and how can wine protein haze formation be best controlled or prevented?		
P.W. Godden	Welcome and introduction	AWRI Roadshow seminar, Langhorne Creek Bowling Clubrooms, Langhorne Creek SA	26 May 06
P.J. Chambers	Issues relating to GMOs and how they affect the Australian wine industry		
P.W. Godden	Results from the AWRI *Brettanomyces* research project: survey data on the incidence of *Brettanomyces* spoilage in Australian wine, and the genetic diversity and morphological differences between *Dekkera/Brettanomyces* strains isolated from Australian wineries; and review of winery applicable detection methods		
E.J. Waters	The 2002 AWRI red wine screw cap trial		
I.L. Francis	Salty wine		
E.J. Bartowsky, S. Dillon[14], J. McCarthy, P.A. Henschke	Potential for fermentation yeast and bacteria to modify red wine colour and flavour – results from recent laboratory and pilot scale experiments		

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Staff	Title of talk	Presented to and where	Date
J.H. Swiegers, I.L. Francis, I.S. Pretorius	An essential role for yeast in the evolution of varietal flavour	AWRI Roadshow seminar, Langhorne Creek Bowling Clubrooms, Langhorne Creek SA	26 May 06
P.A. Smith	Grape and wine tannins, red wine colour and mouth-feel – an overview on current research, emerging applications and future challenges		
E.J. Waters	The link between bentonite requirements and vineyard and winemaking practices		
I.L. Francis	Consumer preferences of Shiraz and Cabernet Sauvignon wines		
E.J. Bartowsky, McCarthy, P.A. Henschke	Which bacterial strains are conducting MLF and what are the consequences?		
P.A. Smith	An industry survey of grape colour, tannin, TSS (Brix and crop yield) – with some implications for winemaking		
P.W. Godden	Strategies for the control of *Dekkera/ Brettanomyces* during winemaking		
E.J. Bartowsky	Microbiology of wine: The good, the bad and the ugly	SA Branch of ASM, Annual General Meeting, Ayers House, Adelaide SA	1 Jun 06
A.P. Pollnitz	Identification and quantification of a ' pepper' marker compound in Shiraz grape berries by combination of chemometrics and GC-MS	54th American Society of Mass Spectrometry Conference on Mass Spectrometry, Seattle Washington, USA	1 Jun 06
S-J. Bell	Maximum residue limits and withholding periods	Evans and Tate Growers Day, Jindong WA	2 Jun 06
	Phosphorous acid and wines for export		
	Resistance management, foliar sprays, Peratec, PMS, wetters and AWIS		
E.J. Waters	The link between bentonite requirements and vineyard and winemaking practices	Technical Staff, Bilyara Winery, Nurioopta, SA	6 Jun 06
C. A. Simos	Welcome and introduction	AWRI Workshop: Trouble free winemaking and the avoidance of wine taints, TAFE SA, Noarlunga Centre, Noarlunga SA (for McLaren Vale winemakers)	9 Jun 06
A.D. Coulter	Taints and their occurrence in wines: Investigations conducted by the AWRI		
G.D. Cowey	Quality management systems		
A.D. Coulter	Simulated tainted/faulty wine tasting		
M.G. Holdstock	Using the AWRI website		
	Methods to assess winemaking chemicals		
A.D. Coulter	Instabilities from wine additives and processing aids		
R.G. Dambergs, D. Cozzolino, W.U. Cynkar, L. Janik, M. Gishen	Rapid analysis of grape and wine quality using ultraviolet, visible, near infrared and mid-infrared spectroscopy	ICASS 2006, 52nd International Conference on Analytical Sciences and Spectroscopy, University of British Columbia, Kelowna Canada	18 Jun 06
J.H. Swiegers, R.L. Willmott, I.L. Francis, M.A. Sefton, I.S. Pretorius	Tailoring wine aroma down under: genetic analysis of volatile thiol modulation by *Saccharomyces cerevisiae*	Seminar. Centre for Malting and Brewing Science, Katholieke Universiteit Leuven, Belgium	19 Jun 06
J.H. Swiegers, R.L. Willmott, I.L. Francis, M.A. 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	Seminar. University of Barcelona, Barcelona, Spain	20 Jun 06
J.H. Swiegers, R.L. Willmott, I.L. Francis, M.A. Sefton, I.S. Pretorius	Flavour-enhancing yeast for varietal expression of Sauvignon Blanc	La Littorale Technical Meeting. Penedés, Spain	21 Jun 06
P.W. Godden	Welcome and introduction	AWRI Roadshow seminar, TAFE SA, Noarlunga Centre, Noarlunga SA	22 Jun 06
S.-J. Bell	The management of Botrytis bunch rot		

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Staff	Title of talk	Presented to and where	Date
C.D. Curtin	Results of the AWRI *Brettanomyces* research project: survey data on the incidence of *Brettanomyces* spoilage in Australian wine, and the genetic diversity and morphological differences between *Dekkera/Brettanomyces* strains isolated from Australian wineries; and review of winery applicable detection methods	AWRI Roadshow seminar, TAFE SA, Noarlunga Centre, Noarlunga SA	22 Jun 06
I.L. Francis	Consumer preferences for commercial Australian Shiraz, Cabernet Sauvignon and unwooded Chardonnay wines		
P.A. Henschke	Winemaking potential with non-*Saccharomyces* yeasts		
P.A. Smith	Grape and wine tannins: an overview on current research, emerging applications and future challenges		
E.J. Bartowsky	Use of lysozyme to control malolactic bacteria during winemaking		
P.A. Henschke, J.M. Eglinton, I.L. Francis	Winemaking with the alternative yeast, *Saccharomyces bayanus:* modification of wine composition, flavour and colour		
M. Nygaard	MCP tannin assay – red wine		
R.J. Blair, I.L. Francis	Accessing information from the AWRI		
S.-J. Bell	Manipulation of phenolic profiles in red grapes and wine by viticultural management		
P.W. Godden	Strategies for the control of *Dekkera/Brettanomyces* during winemaking		
C.B. Colby[9], S.J. Nordestgaard[9], E.J. Waters, B.K. O'Neill[9]	Bentonite fining: Can we improve performance and efficiency and decrease value lossess?	Winery Engineering Association 2006 seminar, Adelaide SA	22 Jun 06
J.H. Swiegers, R.L.Willmott, I.L. Francis, M.A. 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	The 10th International Symposium on the Genetics of Industrial Microorganisms, Prague, Czech Republic	23 Jun 06
D. Cozzolino, R.G. Dambergs, W.U. Cynkar, L. Janik, M. Gishen	Rapid instrumental methods and multivariate analysis: new tools for wine analysis	XXIX World Congress of Vine and Wine and the 4th General Assembly of the OIV, Logroño Spain	28 Jun 06
P.W. Godden	Welcome and introduction	AWRI Roadshow seminar, Hahndorf Resort, Hahndorf SA	30 Jun 06
E.J. Bartowsky, P.J. Costello[6], H. Gockowiak, P.A. Henschke	Strategies for successful induction of malolactic fermentation		
M.J. Herderich	Grape and wine tannins, red wine colour and mouth-feel – an overview on current research, emerging applications and future challenges		
J.H. Swiegers, I.L. Francis, I.S. Pretorius, P.A. Henschke	An essential role for yeast in the evolution of varietal flavour		
S.-J. Bell	Manipulation of phenolic profiles in red grapes and wine by viticultural management		
M. Gishen	Development of new technologies for the prevention of protein haze formation in white wine: a progress report		
P.A. Henschke	Winemaking potential with non-*Saccharomyces* yeasts		
S.-J. Bell	The management of Botrytis bunch rot		
M.J. Herderich	An industry survey of grape colour, tannin, TSS (Brix) and crop yield – with some implications for winemaking		

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Appendix 1. External presentations and talks

Staff	Title of talk	Presented to and where	Date
P.A. Henschke, J.M. Eglinton, I.L. Francis	Winemaking with the alternative yeast, *Saccharomyces bayanus:* modification of wine composition, flavour and colour	AWRI Roadshow seminar, Hahndorf Resort, Hahndorf SA	30 Jun 06
I.L. Francis	Effects of powdery mildew on the sensory properties and composition of Chardonnay juice and wine		
M. Gishen	Red grape colour – why is it important and how can it be measured?		
P.W. Godden	Strategies for the control of *Dekkera/ Brettanomyces* during winemaking		

[1] Flinders University, [2] University of New South Wales, [3] University of South Australia, [4] The University of Adelaide – School of Agriculture and Wine, [5] Orlando Wines, [6] Lallemand Australia, [7] John Field Consulting Pty Ltd, [8] Currently at the Australian Research Council, [9] The University of Adelaide - School of Chemical Engineering, [10] Patrick Iland Wine Promotions, [11] CSIRO Health Science and Nutrition, [12] The Alfred/Monash University, [13] University of Western Australia, [14] Currently at the Yalumba Wine Company, [15] Consultant, UK, [16] Hardy Wine Company, [17] Provisor, 18 University of Stellenbosch, [19] Mauri Yeast, [20] Victoria University, [21] The University of Adelaide – School of Electrical and Electronic Engineering, [22] Berri Estates Winery, [23] McGuigan Simeon Wines, [24] Pontificia Universite Católica de Chile, [25] University of Melbourne

Workshops

Conducted by	Title of workshop	Held	Date
D. Cozzolino, R.G. Dambergs, W.U. Cynkar, L. Janik, M. Gishen	Seminar on Advances in spectroscopy The use of Chemometrics	Presented to Orlando Wyndham Group winemakers and viticulturists, Rowland Flat SA	19 Aug 05
D. Cozzolino, R.G. Dambergs, W.U. Cynkar, L. Janik, M. Gishen	CRCV-Integrated Spectronics prototype instrument demonstration	Riverland Field Days, Berri SA	31 Aug 05
A. D. Coulter	Trouble free winemaking: the identification, avoidance and management of common wine instabilities	Hunter Valley Winemakers' Association, Hunter Valley, NSW	30 Nov 06
P.W. Godden, M. Gishen, A.D. Coulter, G.D. Cowey, M.G. Holdstock	Trouble free winemaking: managing wine instabilities, understanding and managing nitrogen and identifying wine faults	AWRI Workshop, TAFE Tasmania, Newnham Tas	19 Jan 06
C.A. Cimos, A.D. Coulter, G.D. Cowey, M.G. Holdstock	The avoidance of taints and chemical instabilities during winemaking	TAFE SA, Noarlunga Theatre, Noarlunga, SA	23 June 06

Posters

Author(s)	Title of poster	Presented at	Date
D. Cozzolino, M. Parker, R.G. Dambergs, M. Gishen, M.J. Herderich	Qualitative monitoring of red wine fermentation: combining chemometric and near infrared spectroscopy	*InVino Analytica Scientia*, Montpellier France	7-9 Jul 05
R.A. Muhlack, E.J. Waters, B.K. O'Neill[9], A. Lim[16], C.B. Colby[9]	New insights into the adsorption of haze-forming proteins by bentonite during winemaking		
M.J. Kwiatkowski, G.K. Skouroumounis, D. Cozzolino, I.L. Francis, K.A. Lattey, A. Kleinig, E.J.Waters	Impact of ullage volume under screw cap (ROTE) on chemical composition and sensory properties of a Cabernet Sauvignon wine		
S.L. Brown, K.F.Pocock, M.A. de Barros Lopes[3], P.B. Høj[8], E.J. Waters	Reducing haziness in white wine by overexpression of *Saccharomyces cerevisiae* mannoproteins		
M. Parker, P.A. Smith, M. Birse, M.J. Kwiatkowski, H. Gockowiak, K.A. Lattey, B. Liebich[17], I.L. Francis, M.J. Herderich	The effects on red wine of pre- and post-ferment additions of grape-derived tannin		
K.A. Lattey, H.E. Smyth, I.L. Francis	The relationship between wine expert quality judgements and consumer liking for a set of Australian Riesling wines	6th Pangborn Sensory Science Symposium, Harrowgate UK	7-11 Aug 05

Author(s)	Title of poster	Presented at	Date
R.L. Taylor, G.A. Baldock	Chlorophenols- friend or foe?;	20th Conference for Residue Chemists in Wellington, New Zealand	18 -20 Aug 05
S-J. Bell	Manipulation of phenolic profiles in red grapes and wine by viticultural management	14th International GESCO symposium, Geisenheim Germany	22-26 Aug 05
P.J. Chambers, K. Howell[2], M.A. de Barros Lopes[3]	Characterisation of yeast genes involved in flavour determination in wine	22nd International Conference on Yeast Genetics and Molecular Biology, Bratislava, Slovak Republic	7-12 Aug 05
D. Malherbe[18], C. Varela, P.J. Chambers, P. van Rensburg[18], I.S. Pretorius	Modulation of yeast enzymatic activities for the production of low alcohol wines	ComBio 2005 Combined Conference, Adelaide Convention Centre, Adelaide SA	25 – 29 Sept 05
S. Callegari[3], A. Heinrich[19], T.M. Tran, P.J. Chambers, S. Andrews[3], M.A. de Barros Lopes[3]	Identification of genes involved in ethanol tolerance in *Saccharomyces cerevisiae*		
T.M. Tran, J.R. Bellon, S.A. Schmidt, G.A. Stanley[20], P.J. Chambers	Identifying genes that confer ethanol tolerance in *Saccharomyces cerevisiae*		
D. Kutyna, C. Varela, G.A. Stanley[20], P.A. Henschke, P.J. Chambers	Diverting metabolism in yeast to make low-alcohol wines		
E.L. Tan[1], S. Schmidt, P.J. Chambers, E.J. Waters, P.A. Anderson[1]	Expression of 6xHisHpf2 in *Pichia pastoris*		
O.J. Macintyre, P.J. Chambers, C.B. Colby[9], B.K. O'Neill[9], I.S. Pretorius, E.J. Waters	Investigation into the effect of glycosylation on the function of the yeast protein Hpf2		
C.S. Stockley, W. Greenrod[12], M. Abbey[12]	Background diet influences markers of risk for cardiovascular disease after moderate wine consumption	Second international conference on poly-phenols and health, UC Davis, CA USA	4-7 Oct 05
P.A. Smith, E.G. Dennis, M.V. Perkins[1]	Synthesis and characterisation of A-type tannins	2006 International Workshop on Anthocyanins, Rotarua NZ	14 Feb 06
L. Liu[9], D. Cozzolino, M. Gishen, C.B. Colby[9], B.K. O'Neill[9], D. Abbot[21]	Effect of temperature on wine spectra using near infrared spectroscopy	Australian Near Infrared Spectroscopy Users Group conference, Queensland	7-9 May 06
W.U. Cynkar, R.G. Dambergs, D. Cozzolino, L. Janik, M. Gishen	Effect of frozen sample storage on Vis and NIR spectra of red grape homogenates		
C. Bevin[16], D. Cozzolino, L. Janik, K. Goldsack[16], A. Lim[16], W.U. Cynkar, R.G. Dambergs, M. Gishen	Effect of sample presentation on the visible and near infrared spectra of red grapes analysed using a diode array instrument		
M. Vilanova, T.E. Siebert, C. Varela, I.S. Pretorius, P.A. Henschke	Effect of ammonium supplements to musts of Albariño variety: impact on wine compounds	XXIX World Congress of Vine and Wine and the 4th General Assembly of the OIV, Logroño Spain	25-30 Jun 06

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Other activities

Staff	Activity	Date
E.J. Bartowsky	'Science Week' talk on microbiology to Year 6 students at Burnside Primary School	27 Aug 05
P.W. Godden, B.R. Bramley, I.L. Francis, K.A. Lattey, N.E. Cream, G.D. Cowey, A.D. Coulter	Advanced Wine Assessment Course, Waite Campus, Urrbrae SA	20-23 Sep 05 18-21 Oct 05

Appendix 2. Teaching responsibilities of AWRI staff during 2005/2006

Subject	No. of lectures	AWRI staff
2005 — Semester 2		
Adelaide University		
2001WT and 7030WT Wine and Society	2	C.S. Stockley
3005WT Grape Industry Practice Policy and Communication	Approx. 50 hours	C.S. Stockley
3044/7038 Viticultural Methods and Procedures	1	S.-J. Bell
1958 Wine packaging and quality management	1	M. Gishen
3045WT Advances in Oenology	1	R.G. Dambergs
	1	P.W. Godden
	3	E.J. Bartowsky
	5	P.A. Henschke
	1	P.A. Smith
	2	I.L. Francis
3044/7038 Viticultural methods and procedures	1	S.-J. Bell
Flinders University		
BTEC3630 Medical and Molecular Biology	1	P.J. Chambers
BTEC 9670 Bioprocessing and Industrial Biotechnology	2	P.A. Henschke
2006 — Semester 1		
The University of Adelaide		
3007WT Stabilisation and Clarification	1	A.D. Coulter
	3	E.J. Waters
3047WT /3047WA/7047WT Winemaking at vintage	1	P.W. Godden
3045WT Advances in Oenology	1	A.P. Pollnitz
	1	P.W. Godden
3011WT/3011WA/7013WT Winemaking	2	P.A. Henschke
2001WT/7030WT Wine in Society	1	C.S. Stockley
3002WT Biotechnology in the food and wine industries	2	P.J. Chambers
University of South Australia		
FOSC3011 Sensory evaluation of foods	1	D. Cozzolino
Flinders University		
CPES 7014 Aromaticity and Pericyclic Reactions (Honours Course)	12	G.M. Elsey
Universitat Rovira i Virgili, Tarragona, Spain		
Wine Microbiology and Biotechnology	4	I.S. Pretorius

Appendix 3. Graduate and Honours student supervision responsibilities of AWRI staff for 2005/2006

Student	Supervisor/s	Source of funds
PhD		
A. Bandara	G. Stanley[20], S. Frase[20], P.J. Chambers	Victoria University
M. Birse	M.J. Herderich, A.P. Pollnitz, I.L. Francis	CRCV
R.C. Brown	G.M. Elsey, M.A. Sefton, M.V. Perkins[1]	GWRDC/CPGS
E. Dennis	P.A. Smith, M.V. Perkins[1]	GWRDC/ARC
V. Joscelyne	C.B. Ford[4], G. Jones[4], M.J. Herderich	Adelaide University/GWRDC
D. Kutyna	P.J. Chambers, P.A. Henschke, C. Varela, G. Stanley[20]	AWRI
L. Low	B.K. O'Neill[9], D. Lewis[9], C.B. Ford[4], J. Godden[22], M. Gishen, C.B. Colby[9]	GWRDC/Adelaide University

Student	Supervisor/s	Source of funds
O.J. MacIntyre	E.J. Waters, C.B. Colby[9], B.K. O'Neill[9], I.S. Pretorius	The University of Adelaide
I. Mohammed	G. Stanley[20], P.J. Chambers	ARC
C. Payne	S. Bastian[4], M. J. Herderich	Adelaide University/GWRDC
J. Rogers	C.B. Colby[9], M. Gishen, S.J. Clarke[4], B.K. O'Neill[9]	GWRDC/Adelaide University
D. Stanley	G. Stanley[20], S. Fraser[20], P.J. Chambers	Victoria University
T. Tran	P.J. Chambers, G. Stanley[20], M.A. de Barros Lopes[3]	Victoria University and AWRI
S.C. vanSluyter	E.J. Waters , A. Bacic[25], F. Pettolino[25]	University of Melbourne
T. Warren	V. Jiranek[4], M.J. Herderich	Adelaide University/GWRDC
S. Williams	P. Anderson[1], S. Schmidt	Flinders University
C. Wood	A.P. Pollnitz, J.A. Alcald[24], E. Bordeu[24]	Pontificia Universite Católica de Chile/AWRI
Hons		
N. Cain	G.M. Elsey	SoCPES – Flinders University
E. King	J.H. Swiegers	Adelaide University
N. Lloyd	G.M. Elsey	SoCPES – Flinders University
R. Moore	G.M. Elsey	SoCPES – Flinders University
U. Nastuchian	S. Schmidt	Flinders University
N. Warnock	S. Schmidt	Flinders University
Graduate Program		
M. Meagher	I.L. Francis	The University of Adelaide

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Theses completed – Honours/PhD

Student	Hon/PhD	Title of thesis	Supervisors
M.A. Daniel	PhD	Formation and fate of damascenone in wine	G.M. Elsey, M.A.Sefton, M.V. Perkins
A. Heinrich	PhD	Identification of genomic differences between laboratory and commercial strains of *Saccharomyces cerevisiae*	M.A. de Barros Lopes[3] and V. Jiranek[4]
A. Grimaldi	PhD	Characterisation of glycosidase enzymes of wine Lactic Acid Bacteria	E.J. Bartowsky and V. Jiranek[4]

Appendix 5. Media interviews

Date	Staff member	Discussed	Media
4 Jul 05	C.S. Stockley	Low alcohol/low calorie wine	Max Allen, journalist
5 Jul 05	E.J. Bartowsky	Histamine, acetobacter, acetic acid bacteria, diacetyl, lactic acid bacteria, malolactic fermentation	Jancis Robinson, *Oxford Companion to Wine*
8 Jul 05	P.A. Henschke	'Yeast', 'stuck ferments', 'hydrogen sulfide'	
1 Aug 05	P.J. Chambers	Low alcohol wines	*The Australian*
24 Aug 05	C.S. Stockley	Potential health benefits of moderate wine consumption	Rosemary Grant, ABC *Country Hour* (Tasmania)
	I.S. Pretorius	AWRI and 50th Anniversary Seminars	
8 Sep 05	P.W. Godden	Various areas of AWRI research	James Halliday, Mitchell Beazley (UK)
29 Sep 05	P.W. Godden	Various areas of AWRI research, particularly *Brettanomyces*	Jamie Goode, *Harpers* (UK)
12 Oct 05	P.W. Godden	Effects of devices marked for 'rapid ageing of wine'	Max Allen, *Weekend Australian*

Appendix 5. Media interviews

Date	Staff member	Discussed	Media
21 Oct 05	I.L. Francis	Wine flavour	Katie Gibb, *Chemistry World*
24 Oct 05	P.W. Godden	Sensory analysis and specific wine flavour compounds	Tim White, *Financial Review*
	I.L. Francis	Sensory analysis and specific wine flavour compounds	
31 Oct 05	C.S. Stockley	Funding for wine and health-related research	Carlo Flamini, *Corriere Vincolo* (Italy)
2 Nov 05	P.W. Godden	Peter Godden's role and projects at the AWRI for cover story of November 2005 issue of WBM	Cindie Smart, *WBM*
11 Nov 05	C.S. Stockley	Pros and cons of moderate alcohol and wine consumption	Eric Cummings, *Rural Press*
14 Nov 05	P.J. Chambers	GM wine yeast	Karen Hunt, ABC Mount Gambier
15 Nov 05			Max Allen, journalist
21 Nov 05			Chris Snow, *Drinks Bulletin*
1 Dec 05	P.W. Godden	Effects of bushfire smoke on grapes and wine	Frank Smith, journalist
5 Dec 05	P.J. Chambers	GM yeast	*Australian and New Zealand Wine Industry Journal*
6 Dec 05	C.S. Stockley	Wine-induced headaches	Huon Hooke, *Sydney Morning Herald*
8 Dec 05	P.W. Godden	Performance of *Diam* closures in AWRI closure trial	Stuart Todd, journalist (UK and France)
9 Dec 05	P.W. Godden	Closures	Cindie Smart, *WBM*
15 Dec 05	P.J. Chambers	GM Yeast ML01	Christophe Noisette, journalst (France)
17 Dec 05	P.W. Godden	Various areas of AWRI work	Tim White, *Financial Review* and *Australia and New Zealand Grapegrower and Winemaker*
22 Dec 05	I.S. Pretorius	Notion of terroir around the world and different philosophies on winemaking	Etienne Besancenot and Florent Girau, Vinorama, France
9 Jan 06	P.W. Godden	Importance of science to the Australian wine industry	Jamie Goode, *Harpers* (UK)
11 Jan 06	C.S. Stockley	Wine versus other alcoholic beverages	Tony Love, *The Advertiser*
24 Jan 06	E.J. Bartowsky	Wine bacteria in MLF	Helen Greenwood, *Sydney Morning Herald*
9 Feb 06	P.W. Godden	Closures	Paul Sellars, *Weekly Times*
3 Mar 06	P.W. Godden	TCA in spirits	Franz Scheurer, *Australian Gourmet Pages* website
17 Mar 06	P.W. Godden	6-chlorocresol taint and trends in the composition of Australian wine	Tony Love, *The Advertiser*
27 Mar 06	I.S. Pretorius	Skilled immigrants to Australia	Nicolette Burke, News Ltd, *The Advertiser*
11 Apr 06	C.S. Stockley	Pros and cons of moderate alcohol and wine consumption	Karen Bishop, *Sydney Morning Herald*
13 Apr 06	P.W. Godden	Bushfire smoke taint in grapes and wine	Jeanine Beacham, *Augusta Margaret River Mail*
18 Apr 06	M.G. Holdstock	Ideal conditions for cellaring wine	James Lane, *Associated Press*
20 Apr 06	C.S. Stockley	Potential health benefits of wine-derived phenolic compounds	Michiko Smith, *Beyond Productions*
24 Apr 06	I.L. Francis	Wine flavour	Jamie Goode, *Wine Anorak*
4 May 06	P.W. Godden	Yeast conversion of sugar to alcohol and other compounds	James Halliday, Mitchell Beazley (UK)
25 May 06	P.W. Godden	TCA in cheese	Franz Scheurer, *Australian Gourmet Pages* website
6 Jun 06	P.W. Godden	RFID tags	Sally Easton, journalist (UK)
7 Jun 06	P.W. Godden	Wine bottle closures	Mathilde Hulot-Tinon, *La Revue du vin de France, La Revue vinicole internationale, La Vigne* (France), *Wine Business Monthly* (USA)
14 Jun 06	P.W. Godden	UK *Waste & Resources Action Programme (WRAP)*	Sally Easton, journalist (UK)
22 Jun 06	I.S. Pretorius	Biotechnology	Taylor Russell, World Report, USA
27 Jun 06	P.W. Godden	Alcohol concentrations in wine, yeast conversion of sugars to alcohol and other compounds	Jeni Port, *Age*

Appendix 6. AWRI Publications

829 Stummer, B.E.; Francis, I.L.; Zanker, T.; Lattey, K.A.; Scott, E.S. Effects of powdery mildew on the sensory properties and composition of Chardonnay juice and wine when grape sugar ripeness is standardised. *Aust. J. Grape Wine Res.* 11: 66–76; 2005.

830 Cox, A.; Capone, D.L.; Elsey, G.M.; Perkins, M.V.; Sefton, M.A. Quantitative analysis, occurrence, and stability of (E)-1-(2,3,6-trimethylphenyl)buta-1, 3-diene in wine. *J. Agric. Food Chem.* 53: 3584–3591; 2005.

831 Swiegers, J.H.; Pretorius, I.S. Yeast modulation of wine flavor. *Adv. Appl. Microbiol.* 57: 131–175; 2005.

832 Francis, L.; Høj, P.; Dambergs, R.; Gishen, M.; de Barros Lopes, M.; Godden, P.; Henschke, P.; Waters, E.; Herderich, M.; Pretorius, I. Objective measures of grape quality – are they achievable? *Aust. N.Z. Wine Ind. J.* 20: 12–18; 2005.

833 Bartowsky, E.J.; Henschke, P.A. Buttery attribute of wine — diacetyl. Desirability, spoilage, and beyond: butter or no butter. *Pract. Winery Vineyard* 27(2): 50–51, 53–60; 2005.

834 Van Rensburg, P.; Stidwell, T.; Lambrechts, M.G.; Cordero Otero, R.; Pretorius, I.S. Development and assessment of a recombinant *Saccharomyces cerevisiae* wine yeast producing two aroma-enhancing ß-glucosidases encoded by the *Saccharomycopsis fibuligera* BGL1 and BGL2 genes. *Ann. Microbiol.* 55: 33–42; 2005.

835 Gundllapalli Moses, S.B.; Cordero Otero, R.R.; Pretorius, I.S. Domain engineering of *Saccharomyces cerevisiae* exoglucanases. *Biotechnol. Lett.* (2005) 27: 355–362

836 Carrau, F.M.; Medina, K.; Boido, E.; Farina, L.; Gaggero, C.; Dellacassa, E.; Versini, G.; Henschke, P.A. De novo synthesis of monoterpenes by *Saccharomyces cerevisiae* wine yeasts. *FEMS Microbiol. Lett.* 243: 107–115; 2005.

837 Bartowsky, E.J.; McCarthy, J.M.; Henschke, P.A. Spontaneous and induced MLF — do we really know what happens? *Aust. N.Z. Grapegrower Winemaker* (497a): 49–52, 54; 2005.

838 Puglisi, C.J.; Daniel, M.A.; Capone, D.L.; Elsey, G.M.; Prager, R.H.; Sefton, M.A. Precursors to damascenone: synthesis and hydrolysis of isomeric 3,9-dihydroxymegastigma-4,6,7-trienes. *J. Agric. Food Chem.* 53: 4895–4900; 2005.

839 Cozzolino, D.; Chree, A.; Scaife, J.R.; Murray, I. Usefulness of near-infrared reflectance (NIR) spectroscopy and chemometrics to discriminate fishmeal batches made with different fish species. *J. Agric. Food Chem.* 53: 4459–4463; 2005.

840 Siebert, T.E.; Smyth, H.E.; Capone, D.L.; Neuwöhner, C.; Pardon, K.H.; Skouroumounis, G.K.; Herderich, M.J.; Sefton, M.A.; Pollnitz, A.P. Stable isotope dilution analysis of wine fermentation products by HS-SPME-GC-MS. *Anal. Bioanal. Chem.* 381: 937–947; 2005.

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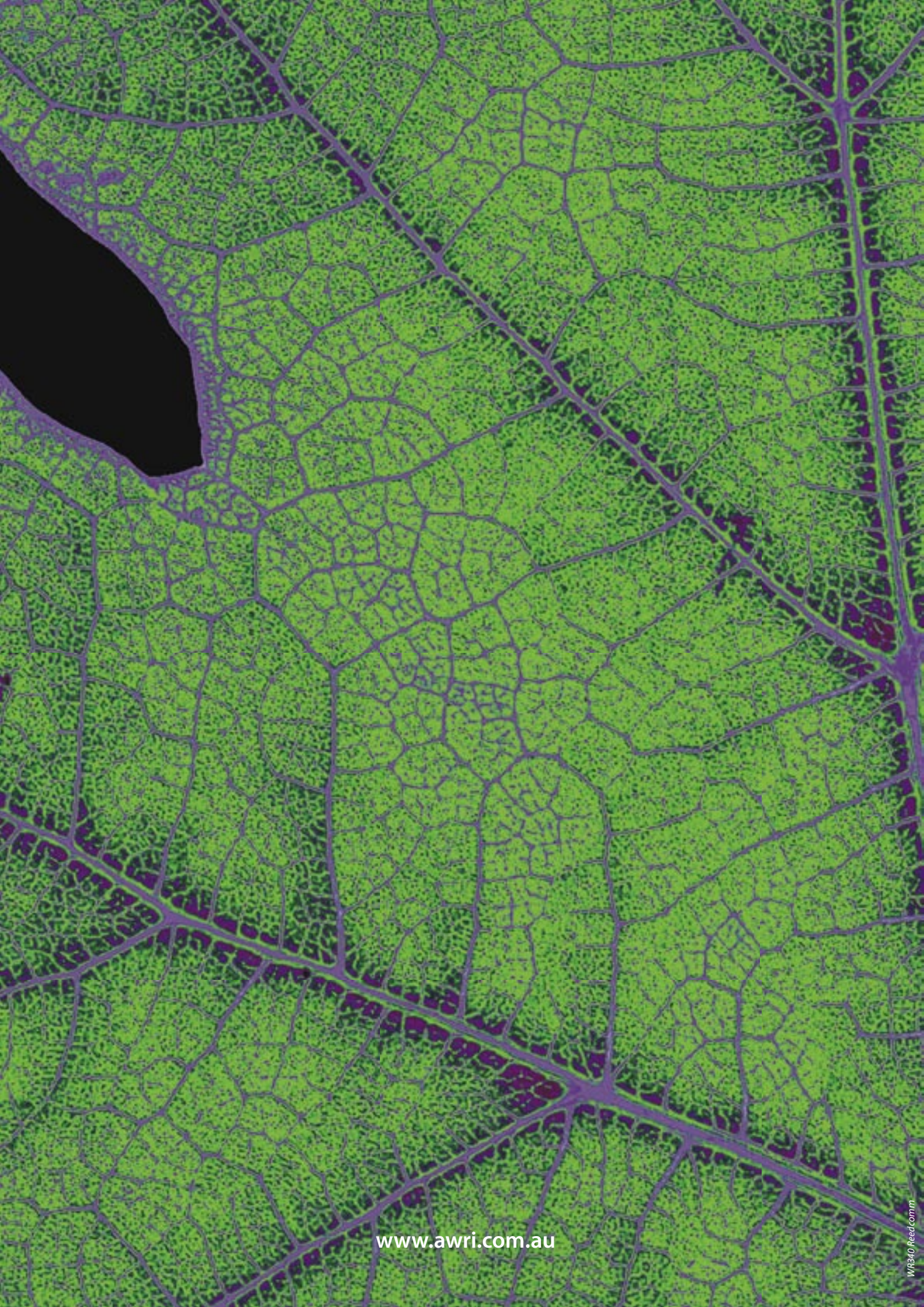
Absent: Mark Sefton, Gordon Elsey, Paul Smith, Kate Lattey, Mango Parker, Les Janik, Gayle Baldock, Mariola Kwiatkowski, Maria Birse, Rachel Brown, Merran Daniel, Creina Stockley, Geoff Cowey, Matthew Holdstock, Catherine Daniel, Melissa Francis, Claire St George, Sandra Lloyd-Davies, Matthew Cream, Carol Sigston, Maria Mills, Hans Muhlack, Linda Halse, Jeff Eglinton, Rachel Edwards, Rhonda Milde, June Robinson, Stella Kassara, Claudia Wood



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