The Australian Wine Research Institute

Annual Report 1999

Council members

Mr D.J. McWilliam, BSc, MSc
Chairman-Elected a member under Clause 6(e) of the Articles of Association

Mr R.E. Day, BAgSc, BAppSc
Elected a member under Clause 6(e) of the Articles of Association

Mr R.L. Gibson, BAppSc, BAppSc
Elected a member under Clause 6(e) of the Articles of Association

Professor P.B. Høj, MSc, PhD
Ex officio under Clause 6(d) of the Articles of Association as Director of the Institute

Mr T.W.B. James, AssDip(WineProd)
Elected a member under Clause 6(e) of the Articles of Association

Mr G.R. Linton, BAppSc(AppChem), GradDip(SysAnal)
Elected a member under Clause 6(e) of the Articles of Association

Professor G.R. Scollary, MSc, PhD, BEd, BAppSc (Wine Science), FRACI
Charles Sturt University Representative under Clause 6(c) of the Articles of Association

Professor R.H. Symons, BAgSc, PhD, FRS, FAA
The University of Adelaide Representative under Clause 6(b) of the Articles of Association

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

Mr G.A. Weaver, BAgSc, RDOen
Elected a member under Clause 6(e) of the Articles of Association

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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 Memorandum of Association of The Australian Wine Research Institute sets out in broad terms the aims of the Institute and the Report of the Committee of Review for the Institute published in March 1977 identified the following specific aims:

1. To carry out applied research in the field of oenology.

2. To service the extension needs of the winemakers of Australia.

3. To be involved in the teaching of oenology at both undergraduate and postgraduate levels.

4. To assume responsibility for the co-ordination of oenological activities, and the collection, collation and dissemination of information on oenological and viticultural research to the benefit of the Australian wine industry.

The Institute's laboratories and offices are located on the Waite Campus of The University of Adelaide at Urrbrae in the Adelaide foothills, on land leased from the University. The original lease is for a term of 99 years, with a right of renewal clause for a further 99 years. The Institute formally affiliated with The University of Adelaide in 1990. The first buildings were erected and opened in 1957 and alterations and extensions were completed in 1976. The buildings have been extensively modified and refurbished since that time with major extensions being undertaken in 1994 and 1999.

The Institute is adjacent to the Faculty of Agricultural and Natural Resource Sciences of The University of Adelaide, three Divisions of the CSIRO and the South Australian Research and Development Institute.

The Australian Wine Research Institute

Annual report
1999

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45th Annual Report – 30th June 1999

Presented to the Australian Wine Industry

Chairman's report

Douglas McWilliam

It is my pleasure to present, to the Industry, the 1998-99 Annual Report for The Australian Wine Research Institute. The staff is to be congratulated for another excellent year of high standard research and service to our industry. Our new Director, Professor Peter Høj, has acquired a good grasp of our Institute's affairs and Council is pleased with his efforts in coordinating the formulation and production of a five-year business and strategy plan for the Institute.

All of industry would now be aware of the successful application for a second Cooperative Research Centre for Viticulture. This is a wonderful result and I particularly thank our staff who put much preparation into their part of the submission and to our Director for the presentation he made to the selection committee. Dr Elizabeth Waters, our Institute's Principal Research Biochemist, has been named as the leader of the CRCV's Program 1, that being titled *Vineyard management to meet grape quality specifications.*

In last year's report, I highlighted our need for building expansion to house increased research staff and our increasing Analytical Service division. I am pleased to say that the new building extension has been designed to be both functional and in harmony with the existing surroundings. Final cost will be just in excess of 1 million dollars and Council is most grateful to the GWRDC for its contributions, which over a three-year period will amount to $375,000. Council is also pleased that the GWRDC has agreed to finance the replacement in 1999/2000 of our ageing TSQ-70 mass spectrometer with a new instrument, a TSQ 7000, which will ensure that our research capability will remain at the leading edge of wine and grape chemical analysis.

Of course, all of this generous financial support could not have been made without our Industry's decision to support increased levy payments for both wine and grape research which is also bolstered by the record national crush of the 1999 vintage. It is both pleasing and surprising to note that in relation to total industry revenue of around 2 billion dollars that our Research and Development levies, which only represent around 0.3% of this figure, have allowed us to establish an international leadership in wine and grape research. The challenge is whether we can maintain our position, profile and advantage at these existing levels of support?

Our Institute continues its strong and healthy relationship with The University of Adelaide and the Wine Science courses, through teaching and the sharing of the University's Hickinbotham Roseworthy Wine Science Laboratory with its impressive pilot and medium scale winery facilities which increasingly will be required for our research effort. Our Council has a strong desire to foster closer ties between wine and grape research. We have encouraged the University to commit to the filling of the position of Professor of Viticulture, a post formally held by our Director, by agreeing to part sponsor both the Professorial Chair of Oenology and Chair of Viticulture.

The Analytical Service and Industry Services Teams have again seen increases in work performed for industry. The planned acquisition of a new GC-MS for the Trace Analysis Laboratory will provide an improved service in this area of unprecedented growth and demand, particularly for agrochemical residue analyses but also for the recently launched oak and cork analyses. Council is sorry to lose the very capable services of Sue Weeks who, over the past years, well represented our Analytical Service to industry and has presided over the division's expansion.

Our Director has been accorded the honour of being invited to be a member of the Prime Minister's Science, Engineering and Innovation Council. One of his first tasks will be to present our Australian Wine Industry as 'an Australian success story' and to highlight the roles of research and innovation that have contributed to its success. This is a great personal honour for Peter and a significant recognition of the part played by our Institute.

In conclusion, I wish to thank all Councillors for their support, all Institute staff for their efforts during the past year and to the broader industry for having the determination and foresight to ensure that our grape and wine research remains the envy of the rest of the world.

D.J. McWilliam
Chairman of Council

The Australian Wine Research Institute

Council notes

Chairman
At the Council Meeting held on 27 October 1998, Mr D.J. McWilliam was re-elected Chairman of Council.

Members of the Executive Committee
Mr D.J. McWilliam
Mr R.L. Gibson
Professor P.B. Høj
Mr T.W.B. James
Professor R.H. Symons
Mr G.A. Weaver

Deputy Members of Council
Mr L.P. Deans
Mr B.C. Duncan
Ms P.A. Dunsford
Mr P.F. Hayes
Mr J. Northey
Dr N.S. Scott
Professor M. Sedgley
Mr P.J. Wall

Meetings
Ordinary General Meeting
The 44th Ordinary (Annual) General Meeting was held on 27 October 1998.
Council
The Council of the Institute met on the following dates: 28 July 1998, 27 October 1998, 23 February 1999 and 4 May 1999. Executive members of Council met on 8 December 1998.

Funding
The Council of the Institute acknowledges the continuing financial support of the Grape and Wine Research and Development Corporation.

Appreciation
The Institute acknowledges the assistance and cooperation of the following organizations throughout the year:

Australian Wine and Brandy Corporation
Australian Wine Foundation
Charles Sturt University
Commonwealth Scientific and Industrial Research Organization (CSIRO)
Cooperative Research Centre for Viticulture
Department of Agriculture, Forestry and Fisheries Australia
South Australian Wine and Brandy Industry Association
State Departments of Agriculture
The University of Adelaide
Winegrape Growers' Council of Australia, Inc.
Winemakers' Federation of Australia Incorporated

The Council of the Institute, from left: Professor Geoff Scollary, Tim James, Professor Bob Symons, Dr Rob Walker, Geoff Linton, Robin Day, Richard Gibson.

Seated: Doug McWilliam (Chairman), Professor Peter Høj (Director)

Absent: Geoff Weaver.

Director's report

Peter Høj

The importance of individual and collective achievements

The Australian Wine Industry and many of its charismatic personalities have, for many years, shown a deep commitment to contribute to the industry's continued development through honorary work on committees including our own Council. The commitment not only sets an example for the younger members of the Industry, but also manifests itself in periodic increases in the funding available for strategic grape and wine research. Following considerable efforts from many Industry and research personnel, we saw another levy increase for grape and wine research with effect from the 1999 record vintage. The levy increase will allow a much needed funds injection into grape and wine research, nationwide, and help preserve the significant assets in human resources and tradition which have been built up through decades of effort. Staff at the Institute are grateful for the continued commitment of the Industry and welcome not only the enhanced security of our own operations, but also the increased ability of other talented Australian scientists to now contribute more fully to the R&D effort of our Wine Industry.

The Institute fully recognises the need for scientists of different skills to collaborate and to 'cluster' abilities in order to make real progress. Clustering can happen in both a physical and mental sense. The Institute is fortunate to be located on the magnificent Waite Campus in Adelaide, where we are co-located with the Faculty of Agricultural and Natural Resource Sciences of The University of Adelaide; the Horticulture unit of CSIRO Plant Industry; South Australian Research and Development Institute; the CSIRO Divisions of Soil and Water, and Mathematics and Information Sciences. This not only secures access to vastly expanded physical resources, but also creates a pool of intellectual knowledge that is way beyond that found in a single organisation (*the environment of the Waite Campus has been used in this Report as the backdrop to the staff photographs*). Even more important than physical co-location is that of 'mental' co-location, irrespective of geographical location. Through the award of yet another Cooperative Research Centre for Viticulture, starting in July 1999, can we achieve just that with research partners including not only Adelaide-based institutions, but, very importantly, large sections of Department of Natural Resources and Environment (Victoria) and The National Wine and Grape Industry Centre comprising sections of Charles Sturt University as well as NSW Agriculture. The Institute's major involvement in the new CRC for Viticulture is in Program 1 entitled *Vineyard management to meet grape quality specification*. This program, which comprises active collaboration from institutions in several States, is led by our Principal Research Biochemist, Dr Elizabeth Waters, and is a strong manifestation of our view that viticultural and oenological research increasingly must be linked.

Closer to home, the year has been very much influenced by the expansion and upgrading of Institute buildings with the addition of some 576m² of floor space to our facilities and refitting of many existing areas. The $1.1 million addition, which will be chiefly funded through accumulated and future income from our business activities and through a $375,000 contribution from GWRDC over three years, will constitute a most important asset for the wine industry and is a manifestation of our sophistication which is displayed with pride to our more than one hundred international visitors each year. The seven-month partial disruption of our activities has been accepted in a great spirit by all staff concerned and I take this opportunity to thank them, not only for great assistance during these trying times, but more generally for their commitment to deliver the best outcomes possible for Industry at all times. In this context the continuous efforts of Rae Blair and Ken Pocock in coordinating the interactions between our builders, Badge Constructions, and the Institute have been exemplary.

Upgraded facilities at The Australian Wine Research Institute

Buildings and infrastructure aside, the most important assets of the Institute is the staff and their accumulated achievements. I shall not spell these out in detail here, as they are highlighted elsewhere, however, in closing I would like to record the Institute's thanks to Nick Bruer and Sue Weeks for their more than ten years of service each within the Industry Services Team and the Analytical Service, respectively, and to Angela Barton for her 6 1/2 years of service to the Administration department. Nick has, after finishing his degree course in winemaking, taken up a position as winemaker with Temple-Bruer Wines. Sue has decided to seek new challenges in her professional life, effective from 8 November 1999. Angela moved to the Riverland to join her husband and to undertake vintage work. We wish them all the best. Finally, we wish to record our best wishes for Peter Hayes who resigned as Executive Director of the GWRDC to take up a position as National Director of Viticulture for Rosemount Estates with effect from January 1999. Peter's continued support for grape and wine research in Australia will undoubtedly have lasting positive effects. Sad as it is to see people 'go', the diffusion of staff back into Industry is probably one of the most effective means of extension available to us.

Peter Høj
Director

Staff

Peter Bordier Høj, MSc PhD *Copenhagen,* Director

Research Team members

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
Ian Leigh Francis, BSc(Hons) *Monash*, PhD *UAdel.*, Senior Research Chemist
Yoji Hayasaka, DipEng(IndChem) *Tokyo I.T.,* MPharm *Vic. Col. Pharm.*, CertIntBusMgt *Monash*, Manager-Mass Spectrometry Facility
Miguel Antonio de Barros Lopes, BSc *Oregon*, PhD *UC (Santa Barbara)*, Molecular Biologist
Eveline Jutta Charlotte Bartowsky, BSc(Hons) PhD *UAdel.*, Research Microbiologist
Zhong Kui Peng, BSc MSc *Zhejiang*, PhD *UAdel.*, Research Chemist
George Kyriakos Skouroumounis, BSc(Hons) *Flinders,* PhD *UAdel.*, Postdoctoral Fellow
Kenneth Frank Pocock, BAppSc *UAdel.*, FAIFST, Senior Chemist
Alan Percy Pollnitz, BSc(Hons) *UAdel.*, Senior Chemist
Daniel Sejer, BSc MSc, *Copenhagen*, Visiting Research Chemist
Peter James Costello, BSc (Hons) MSc *UNSW*, PhD *UAdel.*, Microbiologist
Holger Gockowiak, BSc(Hons) *UAdel.*, Microbiologist
Jeffrey Mark Eglinton, BSc(Hons) *UAdel.,* Microbiologist/Computer Systems Officer
Josephine Louise Newton, BSc PhD *UAdel.,* Casual Research Chemist
Stella Kassara, BSc(Hons) *UAdel.,* Chemist
Dimitra Capone, AssDip(Chem) *USA,* Laboratory Technician
Maria Jolanta Kwiatkowski, MSc *Gliwice,* Laboratory Technician
Wieslawa Cynkar, BSc PhD *Wroclaw,* Technical Officer
Anthony John Heinrich, BBiotech(Hons) *Flinders,* Technical Officer
Gayle Ann Baldock, BSc(Hons) *Guelph,* Technical Officer/Casual Analyst
Scott James McWilliam, BSc *ANU,* Casual Technical Officer (from 15 February 1999 until 2 July 1999)
Jenny Bellon, Part-time Laboratory Assistant
Shauna Liam Brown, BBiotech(Hons) *Flinders,* Postgraduate Student
Anita Oberholster, BSc(Hons) *Stellenbosch,* Postgraduate Student
Catherine Sutherland, BSc(Hons) *UAdel.,* Postgraduate Student
Nicholas Andrew Yap, BSc(Hons) *UAdel.,* Postgraduate Student

Industry Services Team members*

Peter William Godden, BAppSc (Wine Sc) *UAdel.,* Winemaker/Manager Industry Services
Alexander Nikolai Sas, BSc(Agric)(Hons) *UWA,* Viticulturist
Mark Gishen, BE(Chem)(Hons) MEngSc(Chem) *UMelb.,* Quality Liaison Manager
Nicholas Geoffrey Courtenay Bruer, BE(Chem) *UAdel.,* BAppSc (Wine Sc) *CSU,* Oenologist (until 18 December, 1998)
Adrian Dermott Coulter, BSc *Flinders,* Oenologist
Peter Valente, BSc(Hons) *Flinders,* Chemist
Peter John Graves, BSc *UAdel.,* Casual Analyst (until 30 April, 1999)
Raelene Joan Blair, CertAppMgt(Marketing) *AIM*, Communication and Publicity Manager/Personal Assistant to the Director
Creina Standish Stockley, BSc(Hons) *UAdel.,* MSc *Flinders*, MBA *USA,* Health and Regulatory Information Manager
Catherine Grace Daniel, BA *ANU,* GradDip(Lib) *RMIT,* Librarian
Ingrid Betty-Maud Oats, CertLibInfStud *Adel. Tafe,* Library Assistant

*Several members of the Industry Services Team lead or take part in a number of research projects.

Analytical Service

Susan Mary Weeks, GradCertMgmt *USA,* Manager-Analytical Service
John Benjamin Hughes, DipWineMrktg *UAdel.,* Analytical Service Supervisor - Administration
Matthew Grant Holdstock, BSc *Flinders,* Analytical Service Supervisor - Laboratory
Gregory Andrew Ruediger, BAppSc *SAIT*, GradDipOenol, *UAdel.,* Trace Analysis Laboratory Supervisor
Kevin Herbert Pardon, AssDip(AppChem) *SAIT*, Analyst
Andrea Dale Kemp, AssDip(Farm Mgmt), *Roseworthy,* Casual Analyst
Randell Leith Taylor, BSc(Hons) *UAdel.,* Casual Analyst
Radka Kolouch, AssDip(Food Tech) *Czech Republic,* Casual Laboratory Technician
Amanda Louise Cook, AdvCert (Lab Tech) *Mackay,* Casual Laboratory Technician
Matthew James Cream, Casual Laboratory Technician
Jeremy Crispin Hack, Casual Laboratory Technician
Adam Richard Loveys, Casual Laboratory Technician
Adam John Fisher, Casual Laboratory Assistant

Administration

Janet Currie Currie, BA *Glasgow,* MAICD, Company Secretary
Angela Dianne Barton, AssDip(Acc) *Panorama,* ANIA, Accountant (until 22 January, 1999)
Sita Soetratma, BBus(Mgmt) *USA,* Accountant
Carolyn Debra Grant, AssDip(Acc) *Panorama Tafe,* Secretary to the Director
Narelle Elizabeth D'Costa, Accounts Clerk
Emma-Kate White, Receptionist
Maria Concettina Mills, Casual Clerk
Jodi Slade, Cleaner
Robyn Maurmo, Casual Receptionist (until June 1999)

The Australian Wine Research Institute

Highlights of the year

1. The Industry Services Team of the Institute coordinated and initiated one of its most comprehensive projects ever - the 'closure trial'. This trial will examine the technical performance of thirteen different wine closures, including four cork or cork-based products, eight synthetic closures and a screw-cap, for up to ten years. The research will assist to define relevant performance specifications and tests for different closure types.

2. Expanded sensory evaluation confirms a good correlation between grape glycosyl-glucose content and resultant wine flavour intensity.

3. The practical impermeability of wine corks in bottles to externally applied TCA has been demonstrated.

4. Demonstration of the ease and rapidity with which stored wine corks can absorb airborne TCA.

5. Laboratory experiments and an industry trial have shown that ascorbic acid addition to white wine at bottling can accelerate browning during medium to long term bottle storage, and can diminish the anti-browning effects of sulphur dioxide.

6. Trials show that 'stuck' red ferments can be restarted in the presence of relatively high acetic acid concentrations up to 2 g/l.

7. Institute staff co-authored 30 publications; gave 52 seminars/talks (plus the Roadshow seminars); presented 49 posters; conducted 10 workshops; gave 29 lectures and supervised 17 students during the year.

8. Collaboration with BRL Hardy confirms the enormous potential for Near Infrared Spectroscopy for rapid measurement of grape quality parameters such as colour and glycosyl-glucose.

9. A very extensive Roadshow was conducted, when six senior staff spent a period of six days visiting the Swan Valley, Margaret River, Albany and Pemberton in Western Australia.

10. The Analytical Service launched three sophisticated new quantitative commercial analyses: *Oak flavour analysis, TCA analysis and Ethyl carbamate analysis.*

11. The tenth and eleventh Advanced Wine Assessment Courses were held in September and December, with another sixty experienced wine industry personnel further developing and assessing their sensory evaluation skills.

12. An application for a new Cooperative Research Centre for Viticulture in which the Institute is a partner was successful.

13. The Institute and ASVO, through its partnership in AWITC, staged the Tenth Australian Wine Industry Technical Conference in Sydney during August 1998.

14. At the Tenth Australian Wine Industry Technical Conference, the GWRDC sponsored awards for the 'best' posters. Institute staff co-authored three of the five posters selected from over 130 posters for awards:
    - Group of 'Fermentation and Yeast Molecular Biology' posters presented by the Institute;
    - Group of posters covering the 'Tannin project' in collaboration with staff from The University of Adelaide; and
    - *Analysis of oak lactone in wine by stable isotope dilution analysis* authored by Alan Pollnitz, Dr Graham Jones (from The University of Adelaide) and Dr Mark Sefton.

15. The Institute's popular 'Agrochemicals Grid' was launched in August 1998 as a comprehensive website with information on international MRLs regularly updated (www.waite.adelaide.edu.au/AWRI/).

16. Dr Mark Sefton accepted the Wine Industry Innovation and Achievement Award for 1998 for his work involving 'cork taint'.

17. The Director, Peter Høj, accepted the invitation to be a member of the Prime Minister's Science, Engineering and Innovation Council.

18. Institute staff hosted 164 international visitors during the year from countries such as Argentina, Chile, China, France, Germany, Italy, Japan, Portugal, South Africa, United Kingdom and United States of America.

19. Construction of the Institute's new eastern pavilion, measuring ca 576 m^2, commenced at the end of February 1999. It is anticipated that works will conclude September 1999.

The Tenth Australian Wine Industry Technical Conference

The Tenth Australian Wine Industry Technical Conference was conducted by staff of The Australian Wine Research Institute and members of the Australian Society for Viticulture and Oenology and held at the Sydney Convention and Exhibition Centre between 2-5 August 1998. The Conference Planning Committee was Chaired by Professor Peter Høj and the Conference was managed by Rae Blair. Several Institute staff participated on the Conference Planning Committee and assisted in the general running of the event. Eight Institute staff were invited to give a formal presentation, 12 presented at poster break-out sessions and, of the over 130 posters presented, 47 posters were authored or co-authored by staff of the Institute. Over 1200 Australian wine industry personnel and nearly 200 international visitors attended the Conference. The Conference generated a surplus and allowed a subsidy of $15,000 to support the production of the *Australian Journal of Grape and Wine Research.*

The program, held over four days, comprised of eight two-hour sessions and three colloquia. This program was presented by 47 Australian and 9 international speakers, and 23 Chairs/ Moderators. A brief outline of the program is shown below:

Dr John Stocker, *Opening remarks*

Session 1 – Strategy 202 – how do we do it?
Paul van der Lee
The critical elements
Nigel Sneyd, France,
Developing Australia's influence
James Lovell
Quantifying our competitiveness
Professor Peter Høj
Australia's Research and Development effort
David Wollan
Human resource development
Peter Wall
Regulations

Session 2 – Australian wine – securing its future
Greg Rice
22 litres per head-how?
Robin Day
Challenges in the global market
Bill Moularadellis
Kingston Estate - changing the Riverland image
Robert Nicholson, USA
Australia, the brand

Colloquium: The next thirty years – are we ready?
Moderator: Jeffrey Wilkinson
Keynote speaker: Phil Ruthven

Session 3 – Resources
Chris Dundon
2025-have we got what it takes?
Nick Bulleid
Sites for styles
Dr Andrew Walker, USA
Rapid production of planting material
Wayne Meyer
Divining for water
Alf Cass
Assessment of vineyard soils

Session 4 – Impacts
Bob Newman
Environmental controls and options for management
Environmental management:
David Bruer
Case study – vineyard
Sam Glaetzer
Case study – winery
Bob Baxter
Case study – packaging
Dr Ross Nicol
Environmental management- the trends

Session 5 – Specifications
Zelma Long, USA
Defining specifications, a team approach
Dr Leigh Francis
Assessment quality with the G-G assay
Dr Graham Jones
Colour, phenolics and tannins in wine
Russell Johnstone
Vineyard variability- is it important?
Alex Sas
Meeting a salt specification
Peter Godden
Measuring desirable oakwood components in wine

Session 6 – Leading edge molecular biology
Professor Peter Høj
Overview of gene technology
Professor Isak Pretorius, South Africa
Application of gene technology in winemaking
Dr Simon Robinson
Application of gene technology in viticulture
Molecular diagnostics:
Dr John Skerritt
Residue detection
Dr Eileen Scott
Molecular approaches in the study of grapevine pathogens and pests

Colloquium: Will consumers accept gene technology? Will industry adopt it?
Moderator: Dr John Keniry
Professor Nancy Millis
Pathways from laboratory to commercialisation - current and proposed regulatory frameworks
Assoc Professor Loane Skene
Consumer concerns, what are they and are they being addressed ?
Carole Renouf
Genetically modified foods - can we move from consumer reaction to consumer acceptance?
Dr John Smeaton
Experiences in development and commercialisation of gene technology products: an Australian perspective
Geoff Brown, Sainsbury's, UK
Experiences in commercialisation of gene technology products in the food industry

Session 7—Advances in Oenology
Dr Bruno Blondin, France
Biological control of wine acidity by genetically engineered yeasts
Dr Paul Henschke
*The use of non-*Saccharomyces *yeast in winemaking*
Professor Graham Fleet
Alternative fermentation technology
Dr Reiner Wittkowski, Germany
Analytical advances to detect a wine's history
Clark Smith, USA
Application of reverse osmosis in winemaking

From left: Maria Mills, Emma White and Narelle D'Costa

Session 8 – Advances in Viticulture
Peter Clingeleffer
Holistic system approach for sustainable vineyard management for grape and wine quality
Dr Giovanni Martelli, Italy
The impact of propagation on vine health - a European perspective
Dr Peter Dry
Vine manipulation to meet fruit specification
Dr Bob Emmett
Techniques for minimizing disease incidence and residue levels
Peter Scholefield
Vineyard technology - what can we learn from other industries?

Colloquium: Filling and closure technology
Moderator: Paul Tyson
Dr John Field
Fill volume - compliance to domestic and international regulations
Dr Mark Sefton
Cork taint
Richard Gibson
Performance of synthetic stoppers
Geoff Linton
Bottling and corking - critical success factors
Martin Caloghiris
Random postbottling oxidation - causes and prevention

Supplementing the formal program were 12 poster break out sessions with an average attendance of more than 250 delegates at each session. These sessions provided an opportunity for selected poster authors (grouped into themes) to expand on their posters via slide projection. The themes of the breakout sessions were:

1. Soil management
2. Irrigation management
3. Management of waste
4. Wine business management
5. New vineyard technologies
6. Grape and wine flavour and colour
7. Red wine phenolics
8. Microbiological spoilage
9. Vine improvement
10. Disease and pest control techniques
11. Fruit manipulation for wine quality
12. Fermentation

The large static poster display and the poster breakout sessions were coordinated by Alex Sas and proved very popular.

A large trade exhibition was held along side the Conference which featured 105 exhibitors, both from Australia and overseas. The program of the Conference was structured in such a way as to enable time for delegates to view the latest products and services available to the Australian wine industry.

The proceedings of the Conference are nearing completion and will be despatched to delegates in printed and CD format in October 1999.

Staff activities

In addition to undertaking research projects described in this report, the Institute performs a large number of external activities in support of the Australian Wine Industry.

Information on seminars, talks and poster papers given to outside organizations, academic lectures delivered, graduate students supervised, and the papers published is tabulated in Appendices 1-5. Activities in addition to those in the Appendices are described below.

Peter Høj is a member of the Prime Minister's Science, Engineering and Innovation Council and serves on the following Committees and Boards: International Trade and Technical Advisory Committee and Wine Practices Committee of the Australian Wine and Brandy Corporation; the Technical Committee of the Winemakers' Federation of Australia; the Wine Committee of the Royal Agricultural and Horticultural Society of South Australia; and the Waite Campus Management Committee. He is also the Institute's representative on the Faculty's Board; the Advisory Committee and Management Committee of the Department of Horticulture, Viticulture and Oenology, The University of Adelaide. He serves on the editorial board of the *Journal International des Sciences de la Vigne et du Vin*; Committee of Management, Viticultural Publishing, publisher of the *Australian Journal of Grape and Wine Research*. He is also the Chair of the Conference Planning Committee of the Eleventh Australian Wine Industry Technical Conference (7-10 October 2001, Adelaide) - he served the same role for the Tenth Conference (2-5 August 1998, Sydney). He is co-editor of the Proceedings of the Tenth Conference, and is a member of the Australian Organising Committee of the 26th World Congress and 81st General Assembly of the Office International de la Vigne et du Vin (OIV) (11-18 October 2001, Adelaide).

Janet Currie is the Public Officer of the Australian Wine Industry Technical Conference Inc. Rae Blair is a member of the Conference Planning Committee and is the Treasurer and Conference Manager of the Eleventh Australian Wine Industry Technical Conference (she served the same role for the Tenth Conference - 2-5 August 1998, Sydney). She is co-editor of the Proceedings of the Tenth Conference and is also a member of the Australian Organising Committee of the 26th World Congress and 81st General Assembly of the OIV. Creina Stockley is a member of the Australian Wine and Brandy Corporation's International Trade and Technical Advisory Committee and the Legislative Review Committee, and a member of the Technical Committee of the Winemakers' Federation of Australia. Alex Sas was the Poster Coordinator for the Tenth Australian Wine Industry Technical Conference and is co-editor of its Proceedings (2-5 August 1998, Sydney).

Elizabeth Waters is Leader of Program 1 of the Cooperative Research Centre for Viticulture II. Mark Sefton serves on the Editorial Review Board of the *International Journal of Vine and Wine Sciences.* Leigh Francis served as the Program Manager of Program 5 of the Cooperative Research Centre for Viticulture I and has acted as Research program Champion for the Viticulture 2000 Group involved in preparing the bid for the Cooperative Research Centre for Viticulture II. He is also Chair of the Royal Australian Chemical Institute (SA Branch), Medicinal and Agricultural Chemistry Group. Ken Pocock serves on the Waite Campus Occupational Health and Safety Coordinating Committee.

Paul Henschke served on the following committees: Planning Committee and Program Sub-committee for the Tenth Australian Wine Industry Technical Conference (August 1998); and Convenor of Wine Microbiology and Biotechnology IUMS Congress of Mycology Symposium (16-20 August 1999); and Convenor of Microbiology Subgroup of The Interwinery Analysis Group. Paul Henschke served as Program Leader of Program 6 in the Cooperative Research Centre for Viticulture I. He serves on the Editorial Review Board of the following journals: *Australian Journal of Grape and Wine Research; American Journal of Enology and Viticulture; and Australia and New Zealand Wine Industry Journal.* Paul Henschke acted as dissertations examiner for the University of New South Wales.

Peter Godden is a member of the Conference Planning Committee of the Tenth and Eleventh Australian Wine Industry Technical Conferences and the Cool Climate Symposium (Melbourne 1999). Sue Weeks is the Chairperson and Public Officer for the Interwinery Analysis Group Inc.

Visitors to the Institute

International

- Jane Kay, Marks and Spencer, United Kingdom (10 June 1998)
- Michel Bourqui, Office International de la Vigne et du Vin (12 June 1998)
- Dr Terry Lee, E&J Gallo Winery, USA (22 July 1998)
- Dr Michikatsu Sato, Mercian Corporation, Japan (27 July 1998)
- Frédéric Espugne-Darses, Sitevinitech, France (29 July 1998)
- Laurent Dulau and Gordon Specht, Lallemand, France and USA (7 August 1998)
- Clark Smith, Vinovation, Inc, USA (7 August 1998)
- The Hon Prof Mme Jiang Zehui, President, Chinese Academy of Forestry and Vice Chairwoman, Population, Resources and Environment Committee of CPPCC; Mr Liu Xiaozhang, Department of Science and Technology, State Forestry Administration; Mr Dong Qichang, General Office, State Forestry Administration; Mr Zhang Shougaong, Chinese Academy of Forestry; Mr Cai Denggu, Chinese Academy of Forestry; Ms Hu Zhangcui, General Office, State Forestry Administration; Ms Wang Meiyan, Chinese Academy of Forestry; Mr Yang Minsheng, Eucalyptus Research Centre, Chinese Academy of Forestry; Mr Wu Bin and Mr Wu Zhimin Department of International Cooperation, State Forestry Administration; China (16 September 1998)
- Al Oliveira, G.O. Farming Co; Donna Oliveira, Amaral Vineyard; Ron Rankin, J. Lohr Winery and Vineyards; Alan LeBlanc-Kinne, LeBlanc-Kinne Winery Consulting Services Inc; Gordon Murchie, Vinifera Wine Growers Association; Anita Murchie, Vinifera Wine Growers Association; Wilbert Rojewski, Alasco Rubber and Plastics Corporation, USA (26 October 1998)
- Dr Carl Shively, Professor of Microbiology and Fermentation Chemistry, Department of Biology, Alfred University, Alfred, New York, USA (10 November 1998)
- Mr Henrique Martins da Silva, President, Portugese Cork Supply, Dr Marta Sá Pinto, Vinocor, Portugal (18 November 1998)
- Mr Ajay Sooklal, Director, Gambling, Lotteries and Liquor Regulating Office, Department of Trade and Industry, South Africa (19 November 1998)
- M. Larent Dulau, Lallemand France (18 January 1999)
- Dr Tim Unwin, Royal Holloway University, London (19 January 1999)
- Ted Coleman, Winemaker, E&J Gallo Winery, Sonoma, USA (1 March 1999)
- Ambassador of Austria, His Excellency Dr Otmar Koler and Vice-Consul, Consulate of Austria, Mr Manfred Schmid (10 March 1999)
- Gérard CESAR, President Chamber of Agriculture of Aquitane Region and Senator of Gironde region; Joel and Jacqueline BONNEAU, President of Regional Federations of Farmers Unions; Christophe and Marie-Claude TERRIGEOL, Vice President of Chamber of Agriculture Gironde and President of Environment Commission Chamber of Agriculture Gironde, Bernard and Genevieve ARTIGUE, Vice Secretary of Council of Chamber of Agriculture Gironde; Jean-Louis and Elisabeth TROCARD, Secretary of Council of Chamber of Agriculture, Gironde; Jean-Michel and Josette LANDUREAUI, President of National Federation and President Aquitane; Pierre and Claudine GUIGNARD, President of Central and Regional Agricultural Mutual Bank; Joel and Maryse MEYNARD, President of Commission for Tourism and Agri Tourism Gironde; Pierre BERNEDE, President of the Associations for Rural Development Gironde; Alain LIADOUZE, Director of the Chamber of Agriculture, Gironde - visit arranged by the Chambre d'Agriculture de Bordeaux, France (19 March 1999)
- Dr Paul Levine, Hopkins Marine Station, Stanford University, CA USA (22 March 1999)
- Carlos CAGGIATI, Sven NOREIKAT, Javier CASTILLO, Sandra ANDRAOS, Federico PERINETTI, Alberto COTI, Daniel POZZOLI, Dibora DARVICH, Nancy GRANCARA, Antonio RIZZATO, Manual ROMERO, Instituto Nacional de Tecnologma Agropecuaria, Argentina (19 April 1999)
- Professor Mary Ann Smith, Department of Natural Resources and Environment Sciences, University of Illinois, Illinois, USA (21 April 1999)
- Goffredo AGOSTINI, Direttore Cantina Tollo, Tollo CH; Giuseppe ANGILERI, Amministratore Cantina Europa, Marsala TP; Albano ARDESSI, Consultente vitivinicolo, Acquaviva SI; Marilisa BAIT, Centro Riferimento Enologico, Campoformido UD; Alfonso BALDETTI, Consulente Enologica, Cortona AR; Lauro BARBARESI, Consulente Enologica, Grottaferrata RM; Mario BARBIERI, Direttore Cantina Soc. di Tezze, Tezze TV; Attilio BELLACHIOMA, Lallemand Succ. Italiana, Verona VR; Giuseppe BERTO, Evoluzione ambiente, Preganziol TV; Pierfranceso BOLLA, Presidente F.Ili Bolla, Verona VR; Francesca BORNIA, Intec srl., S. Bonifacio VR; Laura BOSCAINI, Cantina Masi, S. Mario in Vegrar VR; Serio BOSCAINI, Presidente Cantina Masi, S. Maria in Negrar VR; Giovanni, CHIARLE, Cantina Soc. Nizza Monf., Nizza Monferrato AT; Gaetano CIOLFI, Instituto Sperimentale Enologia, Velletri RM; Vania CIPRIANI, Firenze FI; Renato DE NONI, Consulente vitivinicolo, Cappella Maggiore TV; Manlio ERBA; Consulente vitivinicolo, Grottaferrata RM; G. Antonio FARRIS, Universita di Sassari, Alghero SS; Enzo FORACE, Consulente vitivinicolo, Mazara del Vallo TP; Alfonso GARBEROGLIO, Consulente vitivinicolo, Firenze FI; Giuseppe LIPARI, Centro Riferimento Enologico, Campoformido UD; Gianluigi MADAU, Universita di Sassari, Sassari SS; Adolfo MAZZOCCO, Verona VR; Pietro MONTALTO, Direttore Cantina Europa, Marsala TP; Gavino NINNIRI, Direttore Sella and Mosca, Alghero SS; Elio NOVELLO, Direttore F. Ili Bolla, S. Pietro in Cariano VR; Lanfranco PARONETTO, Lallemand Succ. Italiana, Verona VR; Marzio POL, Consulente vitivinicolo, Conegliano TV; Adriana PROSPERO, Verona VR; Diletta RECCHI, S. Maria in Negrar VR; Sandra SESLER, Verona VR; Andrea STOCCO, Az. Agricola Stocco, Bicinicco UD; Gianni TRIOLI, Segretario SIVE, Ponte dell'Olio PC; Luciana UNGARO, Tezze TV; Armando VESCO, Intec srl, S. Bonifacio VR, Italy (27 April 1999)

Australian

- Peter Clingeleffer, CSIRO Division of Plant Industry, Merbein, Vic (28 August 1998)
- Group of students from Interlink, Adelaide TAFE (August 1998)
- Peter Halsey, Department of Primary Industries and Energy, Forests Division (16 September 1998)
- Group of 45 students from Annesley College (16 October 1998)
- Grant Wilckens and Chris Atkins, Beston Pacific Corporation Ltd (5 November 1998)
- Ian McKay, Vinocor (18 November 1998)
- Martin Smee, Martin Smee and Associates Pty Ltd (19 November 1998)
- Dr Douglas Mackenzie, Australian Geological Survey Organisation (23 December 1998)
- Dr John Stocker and David Hall, Grape and Wine Research and Development Corporation (8 February 1999)
- Peter Barnes, Chair of the protoboard of the bid for a new Cooperative Research Centre (16 February 1999)
- Greg Underwood, Manager Strategic Planning, Cairns City Council; Professor T. Norman Palmer, Pro-Vice-Chancellor Research and International, James Cook University of North Queensland; John Dean, Chief Executive Officer, Cairns Region Economic Development Corporation (20 April 1999)
- Richard Wood, Bannyan Wood, consultants to the National Wine Centre (21 April 1999)

The Australian Wine Research Institute

Research Teams' reports

From left: Leigh Francis and Mark Gishen

Analysis of quality parameters in grapes and wine using Near Infrared Spectroscopy (NIRS)

Staff: Mark Gishen, Leigh Francis, Peter Høj, Alex Sas, Peter Godden and Wies Cynkar. Bob Dambergs and Bruce Kambouris, *BRL Hardy*. Russell Johnstone and David Sloane, *Orlando Wyndham*.

A new project (GWRDC-funded project AWR 98/2) has been started over the 1998/99 period investigating the potential of Near Infrared Spectroscopy (NIRS) for use as an analytical tool in the wine industry, in particular for application to berry samples. It is considered by many in the wine industry that to continue the quality improvement of Australian wine products, there is a requirement for simple, rapid and cheap techniques to objectively measure parameters that reflect the quality of grapes and wine. Most existing analytical methods are both time consuming and costly, relying on well-equipped central laboratories. NIRS is a correlative technique that has the several advantages of:

- short analysis time;
- little or no sample preparation;
- ability to measure several parameters simultaneously; and
- potential in-field or on-site use (i.e. in vineyard, on mechanical harvesters, or at the winery weighbridge).

NIRS has been used for several years in a number of wine industry laboratories for the measurement of alcohol in wines. It is widely used in other agricultural industries, notably for grains, where it is used as a means of rapidly evaluating the quality of wheat lots as they are delivered to storage and handling facilities.

The most likely immediate application for NIRS for uptake by the wine industry would be colour analysis, which is being targeted as the highest priority in this project. It is evident from extensive practical experience by wineries, as well as from research studies (for example, see Institute publications numbers 127, 151, 233, 283, 285, 333), that grape colour is a practically useful indicator of wine quality for some specific wine styles. There is growing interest by Australian wineries in evaluating grape lots by using colour as an objective specification parameter. If the colour measurement could be done by NIRS, with its inherent advantages, the implications for vineyard management, grape lot identification and segregation would be dramatic, with the likelihood of a tangible improvement in the quality of Australian dry red wine styles. It is possible that the G-G analysis method could be similarly useful, and considering the relatively slow and expensive procedure that must be followed for this assay, if an NIRS calibration for G-G analysis can be achieved, then there could be further potential benefit to the wine industry.

Wineries, at present, are able to simply and accurately measure total soluble solids in grapes using refractometry, and pH using an electrode. However, if colour analysis by NIRS is found to be practical, then the simultaneous measurement of °Brix and pH would be very valuable, and each of these parameters are being investigated in this project. As an extension of existing methods for analysing ethanol in wines, part of this project has involved developing NIRS calibrations for quantifying methanol in spirits for improved ability to control still performance, as an alternative to gas chromatography analysis. Further parameters will be investigated as the project is continued.

This project links closely with other research activities of the Institute: grape flavour, colour and tannin, and fermentation performance, and is integral in Program 1 *(Vineyard management to meet grape quality specifications)* of the new Cooperative Research Centre.

One of the intended consequences of this research will be to facilitate the development of simpler NIRS instruments that may be portable and significantly cheaper than the research grade instrument used to develop calibrations initially. The outcomes of this research project are almost certain to greatly improve a winery's capacity to assess grapes and wines for parameters relevant to wine style and end use.

The Australian Wine Research Institute

The Institute has been working collaboratively with Dr Bob Dambergs (BRL Hardy) and Russell Johnstone (Orlando Wyndham) in this project. Extensive use has been made of an NIR spectrophotometer that was purchased by BRL Hardy. In the short period since the research has commenced, rapid progress has been made. Thousands of samples of several different types have been scanned using NIR instruments, analysed by conventional lab methods, and chemometric data analysis performed.

Development of calibration for measurement of methanol in spirits

An NIR calibration for the determination of the concentration of methanol in spirits has been developed. This was achieved by applying the technique to a large set of distillate (SVR) samples obtained from two commercial continuous stills. However, when spirit samples from another commercial still were included in the calibration set, the methanol concentration was less well predicted by the statistical model. Further work will involve extended chemometric investigation, and analysis of a wider range of samples, to determine whether a calibration model can be made to be universal, independent of the still type or source of distillation material, or whether particular matrix effects need to be accounted for in the model.

The outcome of this investigation will be that companies involved in distillation will achieve substantial analysis cost and time savings due to the rapidity and simplicity of the NIRS approach. There will also be an improvement in the control and optimisation of continuous stills, due to more immediate availability of compositional data on still fractions.

> *NIRS is appropriate for quantification of methanol in spirits*

Development of calibration for measurement of total soluble solids, colour and pH in grapes and grape extracts

The NIRS spectra of approximately four thousand homogenised berry samples have been obtained. The samples were from the varieties Semillon, Chardonnay, Cabernet Sauvignon and Shiraz, sourced from a range of vineyard sites.

Soluble solids

NIRS calibrations for °Brix have been developed (Figure 1), which suggest strongly that total soluble solids can be predicted accurately by an NIRS method, although at present not to the same standard as the reference refractometer method. While optimising sample presentation could improve the calibration in future, it may be that this calibration is sufficient for applications where an accuracy to less than ± 0.1 °Brix level is not critical.

The suitability for NIRS as a method for industry uptake will be dependent on careful consideration of the level of accuracy required. Considering the speed of analysis, it is likely that a slightly reduced degree of accuracy is more than compensated for by the ability to measure many more samples in a given period, so that, for example, during routine grape maturity testing an improved assessment of the whole vineyard can be made.

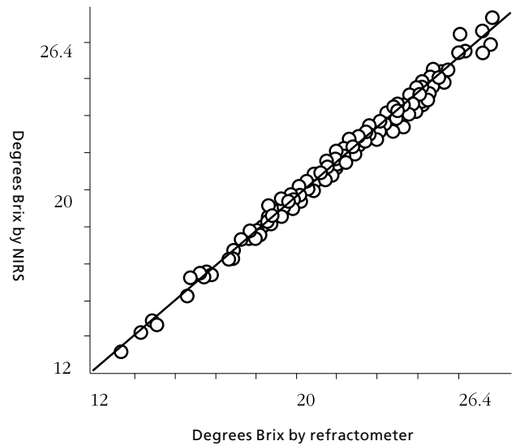
Colour analyses

The conventional method for colour analysis of grape berries requires several steps:

1. homogenisation of the berry sample; followed by
2. subsampling, addition of solvent, and a one hour extraction period;
3. centrifugation;
4. adjustment of the extract to low pH with acid; and
5. a three hour waiting period before a spectrophotometric reading at 520 nm is taken.

NIRS scanning has been applied to samples following step 1, homogenisation, and thus has the great advantage of giving virtually immediate results, with little analyst labour input. For Shiraz and Cabernet Sauvignon samples scanned in this project, mostly from the SA Riverland region, it was found that a good calibration could be developed with the colour spectrophotometric data (see Figure 2 for an example of a calibration obtained for a set of Cabernet Sauvignon samples). Calibrations such as this show that this application is virtually certain to be able to be progressed to enable a robust, accurate NIRS calibration to be produced. Samples sourced from different regions have been obtained and scanned, and preliminary indications are that a universal calibration can be developed, independent of variety or region.
A similarly successful calibration has been obtained for pH (r^2=0.939).

Figure 1. Relationship between Brix values obtained by NIRS and by refractometer for a set of Cabernet Sauvignon berry homogenates (r^2=0.99)



For future work with the colour, pH and total soluble solids applications, it is intended to investigate optimal sample preparation methods, and also to confirm that there is minimal between-region or between-season variation in the calibration produced. The aim is to produce a robust, accurate calibration with the simplest possible sample preparation. Assessment of simplified, cheaper instruments will also be carried out on samples in parallel with more sophisticated instruments.

> *Colour, total soluble solids and pH can be measured with sufficient accuracy by NIRS for some practical applications*

Development of calibration for measurement of G-G (glycosyl-glucose) in grapes and grape extracts

The multivariate calibrations obtained to date, from NIRS scans of approximately 1000 samples correlating with the G-G analytical data, were encouraging (see Figure 3 for an example of a calibration developed for a set of Semillon samples), although with a relatively large standard error of prediction. It is noteworthy that the important wavelengths for the calibration were similar for both white and red varieties, which suggests that the calibration is realistic and not dependent on an artefactual measurement. It is recognised that larger number of samples will be required to be scanned and analysed for G-G before we could be confident of the success of this application. Further work is required to confirm that the wavelengths that are used for the calibration correspond to spectral characteristics of known grape glycosides. Overall this preliminary work has been promising.

Once a reliable calibration has been developed for G-G, the ability of the wine industry to accumulate G-G data on fruit of both red and white varieties will be dramatically enhanced. An NIRS calibration will allow a low cost analysis to be done to allow wine companies to assess the relevance and practical importance of the G-G analysis to their production.

> *NIRS appears promising for the quantification of G-G in grapes*

Yeast flavour and fermentation activity

Staff: Paul Henschke, Eveline Bartowsky, Holger Gockowiak, Jeffrey Eglinton, Scott McWilliam and Michael Fogarty

A recent review of the Yeast Program, detailed in the 1999 GWRDC submission from the Institute, has recommended a shift in the focus from studies directed at reducing well-known fermentation faults to enhancing wine flavour and product value. This change of focus has necessitated the development of collaborations with the Institute's chemists and sensory scientists so as to achieve strong interactive links between research in wine microbiology, wine chemistry, sensory quality and viticultural practices.

Wine is the result of the microbial fermentation of the sugars of grape juice/must and the parallel metabolic transformation/generation of aroma and flavour compounds. Although evident and generally recognised, the microbial control of this process is not fully understood. A full understanding will be the aim of our studies in the future.

Over the past three years, we have performed pilot-studies to evaluate the merits of a microbiological approach to creating flavour complexity in a controlled fashion. Significant progress has been made as outlined in our past annual report for the use of non-*Saccharomyces (Candida stellata)* strains (Soden et al. 1999, submitted for publication) and as outlined below for cryotolerant *(Saccharomyces bayanus)* strains in fermentation studies. In these projects, we have expanded the interaction with the chemists (Dr Mark Sefton) and sensorial experts (Dr Leigh Francis) to not only observe the differences in wine attributes we obtain but also to understand the chemical basis for such changes. These aspects will, in the long term, not only allow us to purpose design wines through the choice of individual combinations of microbial strains, but also to modulate the metabolic generation of individual classes of compounds by these strains.

Two areas of work have formed the main focus of this subproject over the past 12 months:

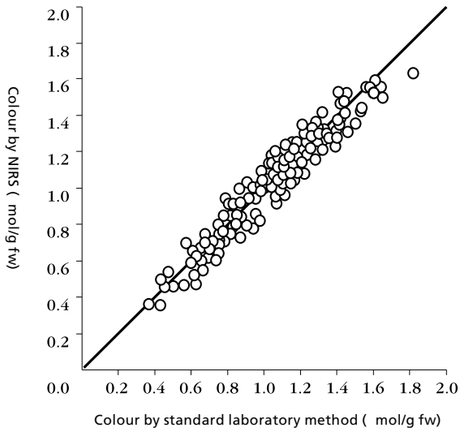


Figure 2. Relationship between colour values (determined as malvidin 3-glucoside and expressed as equivalents of glucose) obtained by NIRS and by the standard laboratory spectrophotometer method for a set of Cabernet Sauvignon grape berry homogenates (r^2=0.964).

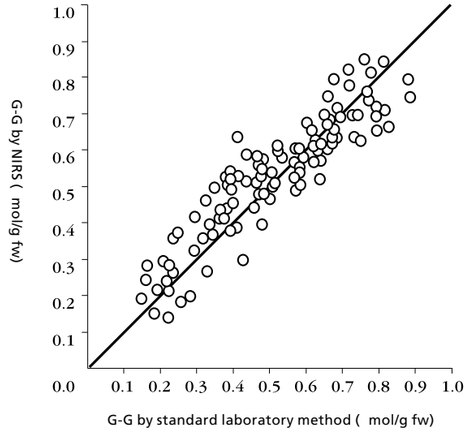


Figure 3. Relationship between glycosyl-glucose values obtained by NIRS and by the standard method for a set of Semillon berry homogenates (r^2=0.805). Ten outlier samples were removed.

From left: Carolyn Grant and Paul Henschke

1. **Evaluation of the winemaking and sensory characteristics of selected non-*Saccharomyces* indigenous wine yeasts.** This subproject previously formed the basis of a PhD research program undertaken at the Institute by Alison Soden. During the 1999 vintage, several experienced winemakers trialed two *Candida stellata* yeasts selected from Alison Soden's PhD studies to evaluate the practical winemaking potential of unconventional yeasts. An emphasis has been placed on the novel sensory attributes of these yeasts and assessing their role for complexing wine flavour. The outcomes of these industry trials will be collated and communicated.

Laboratory fermentation studies

The growth, fermentation, metabolism and wine sensory properties of two cryotolerant *Sacch. bayanus* isolates is being compared with a reference *Sacch. cerevisiae* commercial wine yeast (AWRI 838, clonal isolate of EC1118) in Chardonnay grape juices at 10 and 18°C under simulated winemaking conditions.

> *Production of high quality wines on a laboratory scale was achieved with the* Sacch. bayanus *strains*

Fermentation properties (first trial)

> *At 18°C all three yeast consumed 250 g/L sugar*

> *The concentration of citric, tartaric and lactic acids was similar in wines made with each yeast.*

> *Wines made using* Sacch. bayanus1 *and* Sacch. bayanus2 *at 18°C were characterised by less acetic acid (50%), more glycerol (78%), more succinic acid (108%) and less malic acid (13%) than equivalent wines made with* Sacch. cerevisiae *(AWRI 838).*

> *At 10°C* Sacch. cerevisiae *and* Sacch. bayanus2 *consumed 250 g/L sugar whereas* Sacch. bayanus1 *consumed 225-240 g/L*

> *The* Sacch. bayanus *strains fermented slower than the* Sacch. cerevisiae *strains.*

Chemical composition of wines (first trial)

> *Wines made using* Sacch. bayanus1 *and* Sacch. bayanus2 *at 18°C were characterised by less acetic acid (50%), more glycerol (78%), more succinic acid (108%) and less malic acid (13%) than equivalent wines made with* Sacch. cerevisiae *(AWRI 838).*

2. **Characterisation of cryotolerant *Saccharomyces bayanus* strains.** This work has been undertaken by Jeffrey Eglinton and Michael Fogarty, Honours student, Department of Horticulture, Viticulture and Oenology, The University of Adelaide with assistance and supervision by Professor Peter Høj and Dr Paul Henschke. The initial results obtained by the investigators during the 1998 vintage have been further expanded during the 1999 vintage with technical assistance from Scott McWilliam.

The results of trial 2, to date, have in general confirmed those of trial 1. Wines made with *Sacch. bayanus* contained no residual sugar, less malic and acetic acid than those made with AWRI 838, and twice as much succinic acid and glycerol than control wines. The concentration of ethanol tartaric acid, citric acid and lactic acid, and the pH, were practically identical in all wines.

Sensory analysis of wines

Preliminary sensory analysis by informal assessment showed that the wines made with *Sacch. bayanus* were clearly different in their sensory properties to that made using *Sacch. cerevisiae.* They demonstrated more complex aromas and a less dominant estery fermentation bouquet than wines made with *Sacch. cerevisiae,* while the palate consisted of more developed flavours.

The sensory properties of the wines were analysed by a panel of five highly experienced assessors. Data assessment is still in progress.

> *The sensory properties of each wine were highly dependent on the yeast used for fermentation and to a lesser extent on the temperature of fermentation.*

> *A preliminary sensory assessment of the wines has been made. The wines made with* Sacch. bayanus *possess less fruits and more complex sensory attributes when compared with the wines made with the reference yeast.*

Description and identification of aroma components of wines

The headspace of the wines was analysed by Solid Phase Micro Extraction (SPME)/GC-SNIFF to determine if the differences observed by the sensory panel could be reproduced on an analytical instrument, and to provide a preliminary identification of those compounds which might be contributing to the sensory character of each wine. Approximately 25 peaks of aroma were detected for each wine, although no striking differences in the type of aromas perceived were observed between wines fermented with *Sacch. cerevisiae, Sacch. bayanus1 or Sacch. bayanus2* or at the two different temperatures. Clearly, a more rigorous analysis of the wines by GC-SNIFF would be required to highlight any differences between the wines. Dramatic variation was noted in the apparent concentration of some compounds in the different wines, which could have an effect on the sensory character of the wines. Examples of these aromas were banana/strawberry and rose/floral characters (more intense in the wines fermented with *Sacch. cerevisiae)* and some confectionery/rose/tea characters (which were more intense in some of the wines fermented with *Sacch. bayanus1* or *Sacch. bayanus2*). The ratio of the peak heights of many compounds after separation by GC was also different between the wines.

To further understand the differences between the aroma of the wines, diethyl ether extracts of the wines were analysed by GC-MS. There were no significant differences between the wines in terms of the number or type of compounds which were present in the headspace, which was in agreement with the GC-SNIFF analysis. One compound, tentatively identified as 2-methylpentylbenzene, was present in the wines fermented with *Sacch. bayanus1* and *Sacch. bayanus2*, but not in those fermented with *Sacch. cerevisiae*. This suggests that the aroma difference between wines may be due to a limited number of key impact aroma compounds, and that they may be analytically difficult to detect.

Differences in the concentration of individual compounds were noted, however. For example, wines fermented with *Sacch. bayanus1* and *Sacch. bayanus2* contained 5- and 8-fold more 2-phenylethanol (rose aroma), respectively, than wines fermented with *Sacch. cerevisiae*, regardless of the temperature of fermentation. *Sacch. cerevisiae* produced between 2.5 and 3.0 times as much isoamyl acetate (banana aroma) as *Sacch. bayanus1* and *Sacch. bayanus2* at 18°C, and between 7.6 and 8.9 times as much at 10°C. Another ester which was produced in a greater amount by *Sacch. cerevisiae* relative to *Sacch. bayanus1* and *Sacch. bayanus2* was ethyl hexanoate (approximately 2-fold higher concentration). The ratio of 2 phenylethanol, tyrosol, and tryptophanol (the products of metabolism of the amino acids, phenylalanine, tyrosine and tryptophan, which have a similar metabolic pathway) was also different for the two species of yeast.

From left: Jeff Eglinton, Peter Costello and Holger Gockowiak

> *The fermentation temperature affected the concentration of individual compounds formed by each yeast, but had a similar effect on each yeast, regardless of species.*

> *The chemical analyses outlined very clear differences in concentrations of some known aroma compounds.*

Conclusion

The wines made by fermenting Chardonnay grape juice with two strains of *Sacch. bayanus* were clearly different in their sensory properties to that made using *Sacch. cerevisiae.* The wines were of sufficient quality and sensory character to warrant further investigation of these strains as commercial winemaking yeasts. The overwhelming consensus of those who have assessed the wines is that these wines have potential for blending to enhance complexity in wines fermented using commercial *Sacch. cerevisiae* yeast. The *Sacch. bayanus* strains might also have some application in the production of some specific wine styles and types, such as sparkling wine base and Pinot Noir table wine. The longer fermentation kinetics of the *Sacch. bayanus* strains could be explained by the lack of optimisation of the chemical composition of the juice, since little is known about the nutritional requirements of this species under commercial conditions. Further research will be required to more accurately determine the nutrient requirements of *Sacch. bayanus1* and *Sacch. bayanus2.*

Larger scale evaluation studies

The *Sacch. bayanus* strains are also undergoing preliminary trials under small-scale winery conditions at The University of Adelaide's Hickinbotham Roseworthy Wine Science Laboratory at the Waite Campus, and at several commercial wineries. Wines made at the former location have been bottled and have undergone some standard chemical analysis.

> *Preliminary trials are being undertaken by several wineries to gauge the commercial potential of the* Sacch. bayanus *yeasts.*

Selection of wine yeast and malolactic bacteria for desirable glycosidases and wine sensory enhancement (UCS 92/4)

Staff: Dr Chris Steel *(Charles Sturt University),* Paul Henschke

Work at the Institute and elsewhere has demonstrated that many grape flavour precursor compounds exist as glycosides. These compounds, being non-volatile do not contribute to wine aroma until subjected to acid or enzyme catalysed hydrolysis. Currently impure commercial preparations are available for addition to musts and wine for enhancing the flavour properties of wine, such as monoterpenes (Hagan 1997-ASVO Seminar, Melbourne). The aim of this project was to systematically identify and characterise wine yeast and bacteria with glycosidase activity so that wine flavour enhancement by way of release of glycosidically bound flavour compounds may be performed in a controlled and predictable manner during the alcoholic or malolactic fermentations.

This subproject has been a collaboration between Charles Sturt University and the Institute with Drs Chris Steel and Paul Henschke as project supervisors from the respective organisations over the past year. Funding to the project UCS 92/4 ceased at December 1998. Certain aspects of this project will be incorporated in the Yeast and Wine Flavour project at the Institute.

Fermentation studies with isolated glycosides in model media

Previously we reported on the screening of a number of wine yeasts for glucosidase activity using a liquid medium consisting of malt extract, yeast extract, glucose and peptone (MYGP). This medium used an artificial substrate for glucosidase activity, *p*-nitrophenyl- -D-glucopyranoside (p-NPG). This method, however, need not necessarily provide an indication of glucosidase activity where naturally occurring grape glycosides are the substrate. This is important since the glycosides of wine are responsible for many of the flavour and aroma qualities of wine, once they are hydrolysed. Glucosidase activity was, therefore, examined in a number of wine yeasts using grape glycosides, purified from grape juice and incorporated into a chemically defined grape juice (CDGJ) medium. The Glycosyl-Glucose (G-G) assay was used to determine the extent of -glucosidase activity during the fermentation. Glucosidase activity was determined on the basis of a decrease in the G-G (μmoles) content of the juice. The isolation of the glycosides and fermentation studies were done at Charles Sturt University while the G-G assays were performed at the Institute.

> *The glycosidic activity of yeast, as determined by an artificial glucoside, was confirmed with an isolated authentic grape glycosidic fraction, however, quantitative differences were noted with the two substrates tested.*

> *Up to 40% of the G-G content of the grape glucosidic fraction was reduced by yeasts in a chemically defined fermentation medium.*

> *The kinetics of glycosidic activity directed towards isolated grape glycosides during fermentation in a chemically defined medium varied with the type of yeast.*

> *These findings need to be confirmed in grape juice and supported by organoleptic studies.*

Nitrogen and oxygen metabolism of yeast

Staff: Holger Gockowiak, Jeffrey Eglinton, Paul Henschke

The focus of this subproject has been redirected in the light of recent developments coming out of France (Sablayrolles et al., J. Ferment. Bioeng. 82: 377-381; 1996; Manginot et al., Enzyme Microbiol. Technol. 20: 373-380; 1997). The Institute has over many years contributed to the area of understanding stuck fermentation. Based on current understanding, considerable time will now be devoted to developing written manuals to reduce the risk of those problems occurring. Currently, two experimental areas of work are being performed under this subproject: 1. Amino acid content of grapes, and 2. Evaluation of combined nitrogen and oxygen supplementation as a preventative strategy for stuck fermentation. Trials are in progress and will be reported in a subsequent annual report.

The Australian Wine Research Institute

Research Teams' reports

> *Combined supplementation of ferments with nitrogen and oxygen may provide a general practical strategy for reducing the incidence of slow or stuck fermentation. The optimal timing of supplementation will be established.*

Molecular improvement of wine yeast

Staff: Miguel de Barros Lopes, Paul Henschke, Eveline Bartowsky, Jeff Eglinton, Catherine Sutherland, Anthony Heinrich, Nicholas Yap.

Species differentiation and genetic similarity of wine yeasts

The research is virtually complete and has led to several publications e.g. Institute publications no. 361, 532, 565 and 589. The objective was to develop a molecular technique for identifying both *Saccharomyces* and non- *Saccharomyces* wine yeast at the strain and species level. More recently, work has focused on establishing genetic relatedness amongst the *Saccharomyces* wine yeast using the molecular technique of amplified fragment length polymorphisms (AFLP). This technique also offers a greater ability to distinguish closely related strains. Over the past year, the PCR methods developed have been used in collaboration with wineries to study wine yeast ecology and is now being used to establish the identity of yeasts used for fermentation trials, e.g. *Sacch. bayanus* strains 1 and 2.

Development of a high glycerol reduced ethanol wine yeast

As outlined in previous Annual Reports, a strategy has been devised to increase glycerol production and reduce the ethanol concentration of wine by genetic modification of a wine yeast. The *Saccharomyces cerevisiae* glycerol phosphate dehydrogenase gene, *GPD2*, was isolated using the polymerase chain reaction (PCR) and overexpressed in a commercial wine yeast EC1118 (EC1118-GPD2). Grape juice fermentation trials demonstrate that overexpression of *GPD2* led to a significant increase in the glycerol produced during fermentation (12 - 15 g/L, compared to 5 - 7 g/L for EC1118). The alcohol concentration decreased by 0.5%. The acetic acid levels in the wines also changed, increasing 3-fold.

The research in the last few months has focused on reducing the acetic acid in yeasts producing more glycerol. One strategy has been to delete an aldehyde dehydrogenase *(ALD)* gene in a strain over expressing *GPD2*. An *ALD* gene has been deleted from a laboratory strain of *Saccharomyces cerevisiae* by Jeff Eglinton as part of a PhD project under the supervision of Dr Peter Langridge, Department of Plant Science, The University of Adelaide and Dr Paul Henschke. These modified strains produce less acetic acid during a laboratory fermentation (manuscript in preparation).

> GPD2 *overexpression*/ALD *deletion laboratory strains have been constructed and fermentations are being done to test whether the absence of the* ALD *protein reduces acetic acid production when glycerol synthesis is increased.*

Malolactic fermentation and wine flavour

This project is divided into four sub-projects. A review of this project, as documented in the GWRDC submission for 1999/2000, has led to a revision and focus of priorities of the subprojects. Work on the sensory aspects of MLF will be expanded while work on yeast/bacterial interactions and bacterial identification will be concluded in the next year.

Sensory attributes associated with malolactic fermentation

Staff: Paul Henschke, Eveline Bartowsky, Holger Gockowiak, Peter Costello

One of the principal flavour effects of the bacterial malolactic fermentation (MLF) is the change in the 'butter/butterscotch' attribute in wine. This attribute is due largely to diacetyl, a transient metabolite of citric acid and sugar catabolism by lactic acid bacteria. Our initial aim of this project is, therefore, to improve our understanding of the physiology of diacetyl metabolism in *Oenococcus oeni* (formerly *Leuconostoc oenos)* so that improved strains may be identified and practices developed to give winemakers better control over this important wine flavour component.

Diacetyl

Good progress has been made with the first objective concerning the development of a stable isotope GC/MS method for determining total diacetyl in wine which has been completed and published (Institute publication 584).
A major focus of this subproject is to develop an understanding of diacetyl formation in wine as a precursor to a broader study of MLF's ability to contribute to flavour and aroma of wine. This aim is currently being pursued with two different experimental approaches, one winery based and the other laboratory based.

Evaluate commercial cultures and protocols for the optimal induction and completion of MLF and provide information to winemakers for increasing the reliability of the MLF.

This objective is undertaken by Holger Gockowiak and aims to develop protocols and provide information to increase the reliability of induction and completion of MLF.

The experimental work has now essentially been completed with the outcomes of the three trials summarised in previous annual reports (GWRDC 1996/97, 1997/98). This work is being written up for publication; the first draft of a manuscript *An evaluation of inoculation protocols and commercial starter cultures on progress of MLF in wine* has been written and a rough draft on the *Influence of pH and alcohol content on MLF induced by direct inocula* is in progress.
Much of the information acquired has already been presented during Institute Roadshows (SA, Vic and Tas in 1997, and WA in December 1998) and industry technical conferences (Ninth Australian Wine Industry Technical Conference, 1995 and Tenth Australian Wine Industry Technical Conference, 1998).

Development of a model medium for malolactic fermentation

Of four published media for cultivating wine lactic acid bacteria, that of Liu et al. (1994) was previously chosen for studying citrate and diacetyl metabolism, however, incomplete MLF was encountered. Peter Costello is continuing studies on modifying a more complex defined medium, also published by Liu et al. (1995), but preliminary results again indicated a problem with this medium when used to model wine conditions (pH 3.5, ethanol 10 % [v/v] and citric acid [0.5 g/L] was present). A black precipitate formed and obscured spectrophotometric estimation of cell numbers.

A new medium which has been formulated upon the chemically defined grape juice medium of Henschke and Jiranek (Institute publication no. 424) and supplemented with certain carbohydrates, purines, pyrimidines and other compounds from the Liu et al. (1995) medium supports adequate growth of *O. oeni* even after three successive subcultures. However, a lag phase of 2-3 weeks indicates that the cells are undergoing extensive adaptation to the medium, and that the medium nutrient content is clearly not yet optimal. Interestingly, growth only occurred under strict anaerobic conditions (complete absence of oxygen) (three commercial strains tested), emphasising the requirement for the absence of oxygen for growth under limiting conditions; an atmosphere of 10% CO_2 in air, commonly used for culturing lactic acid bacteria, only allowed poor growth by comparison with the strict anaerobic environment.

The effect of supplementing the medium with more complex nutritional compounds on the lag period and growth yield has indicated their importance. For example, mixtures of peptides in the form of casein hydrolysate and various peptones, reduced the lag period by up to 70% and increased cell yield by several hundred percent. However, a crude grape glycosidic fraction did not provide any growth enhancing benefits. While these results are encouraging, the chemically undefined nature of the supplements does not benefit the aim of developing a fully chemically defined medium for modeling the MLF.

> *Published media for modeling the MLF under conditions resembling those of wine did not provide satisfactory performance for all five strains tested; studies to improve the performance of the medium are in progress.*

From left: Anthony Heinrich and Miguel de Barros Lopes

> *A new modified medium (combination of a published synthetic grape juice and a wine medium) at wine conditions supported bacterial growth, however, with an extensive lag/adaptation phase.*

> *Growth of three bacterial strains under limiting conditions in the new modified medium was only observed in the complete absence of oxygen in an anaerobic chamber.*

> *Preliminary experiments suggest that more complex nutrient supplements can reduce the extent of the adaptation phase and increase biomass of malolactic bacteria.*

Investigate methods for malolactic bacteria strain identification

Rapid DNA fingerprinting of Oenococcus oeni *strains*

The PCR-based technique, RAPD (Randomly Amplified Polymorphic DNA), is being developed as a rapid method for DNA fingerprinting different strains within the genus of *O. oeni*. This technique will then be used to study the ecology of the MLF of commercial wines, such as recently conducted in the Coonawarra region (see GWRDC Projects AWR 5 *Microbiological analysis of industry technical problems* and AWR 11 *Evaluation of new analytical techniques and processing aids for winemaking*). In addition, we have successfully used this technique to fingerprint other species of wine bacteria, in particular, acetic acid bacteria (GWRDC Project AWR 5).

The technique is being adapted for analysis of colonies directly from agar culture plates without the need for laborious DNA extraction. For routine analysis, such as for ecological studies performed on wine, a simple, rapid method is essential for the timely processing of a large number of samples to avoid the problem of sample deterioration. When purified chromosomal DNA is used as the PCR template in RAPD analysis, the generation of a DNA

fingerprint is reliable, however, the method has not yet proven reliable for the direct analysis of bacteria. We are currently examining various methods for the rapid preparation of crude extracts of chromosomal DNA which will allow a reliable DNA fingerprint to be generated.

> *The design of a RAPD PCR technique using purified template DNA from* O. oeni *is successful; work is in progress to develop a rapid, reliable method for the direct analysis of bacterial colonies taken from agar plates. The manuscript* Specific detection of the malolactic fermentation bacterium *Oenococcus oeni* in grape juice and wine samples by PCR *has been published in the* Australian Journal of Grape and Wine Research. *(Institute publication no. 597)*

formulate recommendations for controlling and preventing recurrence of the particular problem.

Current projects concern identification of wine oxidative spoilage bacteria, acetic acid and restarting stuck fermentation, evaluation of analytical methods for nitrogen determination in grape juice and wine, studies on understanding the development of mousy taint in wine, evaluation of chromogenic agar for the rapid differentiation of wine isolates of yeasts, and an industry collaborative trial to determine the efficacy of commercial inocula for inducing the malolactic fermentation of wine.

stored in bottles placed in a vertical position. The sporadic distribution of affected bottles in a batch may be associated with different permeability of the corks to air. The unpredictable nature of the spoilage, and the unknown type and source of bacteria is of serious concern to wineries.

A collaborative project has previously been established between a participating winery, The University of New South Wales (Professor Graham Fleet's research group) and the Institute (Eveline Bartowsky and Paul Henschke) with the aims to isolate, identify, characterise and establish the ecology of the organism(s) in the winery. Progress has been reported in previous annual reports.

From left: Mark Sefton and Eveline Bartowsky

Microbiological analysis of industry technical problems

The Institute has a group of microbiologists with a diversity of applied beverage/food industry skills and experience, and who are well suited to problem solving of a non-routine nature. The main purpose of this project is to undertake a small program of applied research on microbiological problems of general interest to the wine industry, and to

Microbial spoilage of wine by acetic acid bacteria

Staff: Eveline Bartowsky, Professor Graham Fleet *(UNSW)* and Paul Henschke

Over recent years, the incidence of oxidative microbial associated spoilage of, especially, bottled red wine has been noted. The spoilage is often characterised by elevated levels of acetaldehyde and volatile acidity, and sometimes a microbial 'ring' on the neck of the bottle adjacent to the surface of the wine. The spoilage is most often associated with wine that has received minimal treatment with sulfite, has not been membrane filtered, and is

Using classical identification techniques (biochemical tests, microscopical analysis), the bacterial isolates were presumptively classified as acetic acid bacteria, and were likely to be a species of *Acetobacter.* These isolates, however, differ from culture collection species by being very difficult to propagate and maintain. Media which are routinely used for acetic acid bacteria have only been partially successful in maintaining these bacteria. The inclusion of ethanol (wine) in the medium has been essential to the isolation and propagation of these bacteria, however, progress is being hampered by the deterioration of cultures maintained in the laboratory.

Work is in progress with the aim to improve the conditions of laboratory culture and maintenance of these bacteria.

Molecular techniques, previously developed for *Oenococcus oeni*, have been adapted to further characterise these bacterial isolates. A PCR (polymerase chain reaction) technique, designed to detect several species of *Acetobacter*, has been developed, and indicates that the isolates are members of this genus. A DNA fingerprinting technique, RAPD (random amplified polymorphic DNA) is being used to establish the strain diversity of these isolates. The work is now progressing towards establishing the source(s) of these bacteria in the winery environment.

> *The causative agents of the microbially induced oxidative spoilage of bottled red wines were identified as* Acetobacter, *the species has not yet been established.*

> *Molecular techniques developed for the malolactic bacterium,* Oenococcus oeni, *have been readily adapted to the acetic acid bacteria.*

> *The DNA fingerprinting technique, RAPD, is being used to establish the strain diversity of the acetic acid bacterial isolates. An understanding of the winery ecology of these bacteria may shed light on their source.*

> *Knowledge of the type of spoilage bacterium has assisted a winery to implement measures designed to reduce the incidence of microbially induced oxidative spoilage of bottled red wine. However, the preventative measures have required a considerable change in wine processing procedures. A better knowledge of the biology of these bacteria may allow greater flexibility in the production of bottled red wines.*

> *Preliminary results from this work were communicated to industry by presentation of a poster and talk at the 10th Australian Wine Industry Technical Conference.*

Acetic acid toxicity and restart of stuck fermentations

Staff: Jeff Eglinton and Paul Henschke

The results and conclusions of the completed experimental work were documented in the previous Annual Report. A summary of this work, entitled *Restarting stuck fermentations which contain high volatile acidity,* was communicated to industry in the form of a poster and talk at the 10th Australian Wine Industry Technical Conference held in Sydney from 2-5 August 1998. A manuscript, *Restarting incomplete fermentations: the effect of high concentrations of acetic acid* has been published in the *Australian Journal of Grape and Wine Research,* issued August 1999 (Institute publication number 596).

Nitrogen composition of grape juice: analytical methods

Staff: Holger Gockowiak, Mark Gishen, Dr Robert Dambergs *(BRL Hardy),* Russell Johnstone *(Orlando Wyndham),* Leigh Francis and Paul Henschke

The nitrogen content of a juice or must is an important determinant of yeast fermentation activity and wine composition and flavour. Near Infrared Spectrometry (NIRS) is being evaluated as a new rapid method for the determination of yeast assimilable nitrogen (YAN) content of juice. Two methods are being used to calibrate the NIRS method. Amino nitrogen, calculated from the amino acid plus ammonium content, will be determined as the primary reference method using established methodology. The second method, based on reaction between the alpha amino group and o-phthaldialdehyde /N-acetyl-L-cysteine (OPA/NAC), has recently been validated by the Institute's Analytical Service, and was provided as a fee-based method for the 1999 vintage. A collaboration has been formed with Mark Gishen, BRL Hardy and Orlando Wyndham for evaluating NIRS as a rapid technique for juice nitrogen quantification.

Approximately 90 samples have been collected from a Riverland and Barossa Valley winery during the 1999 vintage, and Near Infrared Spectrometry (NIRS) analysis and yeast assimilable nitrogen determination has commenced. The focus of the present trial is constrained to white varieties for which knowledge of nitrogen content is especially important. Two industry notes have been published promoting the use and benefits of the OPA/NAC method, established by Analytical Services as a fee based service, for grape juice YAN determination (Institute publication number 587) and published in *Technical Review* (118): 6-10; 1999.

> *Approximately 90 juice samples have been collected from the two participating wineries during the 1999 vintage for NIRS and YAN analysis.*

> *Two industry notes promoting the use of YAN determination, provided as a service to industry, have been published.*

Mousy off-flavour occurrence and formation in wine

Staff: Peter Costello, Dr Paul Grbin (CSU) and Paul Henschke

Peter Costello submitted his PhD thesis on the role of wine bacteria in the formation of mousy taint in wine for external examination in October 1998 and was recommended award of the PhD degree by The University of Adelaide. Manuscripts are being drafted to report on the role of the microorganism and nutrient conditions on mousy off-flavour formation, and on proposing the mechanism of N-heterocycle formation. Aspects of this work were recently presented to winemakers and scientists both nationally and internationally (see Appendix 1).

Grape composition and wine flavour

Staff: Leigh Francis, Elizabeth Waters, Yoji Hayasaka, Stella Kassara, Mariola Kwiatkowski, Gayle Baldock

The Glycosyl-Glucose (G-G) assay

As discussed in previous annual reports, the G-G assay quantifies the amount of glycosylated secondary metabolites in grape, juice or wine samples. The glycoside pool has been shown by a series of studies to be of relevance to wine flavour, acting as aroma precursors. Following collection of several years' worth of data in the form of a national survey, we now have an improved understanding of the possible role of the G-G assay in practical viticulture.

The data from the analysis of the thousands of berry samples derived from the National Vineyard Fruit Composition Survey (NVFCS) has been assessed. The samples were obtained from commercial vineyards

and from research trials from the 1996 to 1998 seasons and some of the data have been published in several outlets. Further disclosures of the results will be made. Preliminary data regarding grape G-G and wine sensory properties was discussed in the 1998 Annual Report, and from further data analysis, it is evident that a statistically significant correlation exists between grape G-G and wine flavour intensity scores for the samples obtained as part of the NVFCS. As previously reported, for red wines the anthocyanin concentration of the grapes also correlated with flavour intensity.

A number of white grape samples analysed as part of the NVFCS survey have been recently re-analysed using a more sensitive fluorescence method to quantify glucose, to confirm some results which were displaying some 'noise'. Use of fluorescence improved the sensitivity of the glucose analysis and reduced the variability of the data set. In addition, some experiments have been carried out to improve the sensitivity of the G-G assay for white berry samples when a standard UV-Visible spectrophotometer is used for quantification of glucose.

Phenolic-free G-G is the fraction of G-G which does not include phenolic compounds such as anthocyanins. Grape samples from which wine sensory scores are available have been analysed for phenolic free G-G, and this data set suggests that phenolic free G-G correlates poorly with wine flavour intensity.

> *Based on a large data set, it is evident that a statistically significant correlation exists between grape G-G and wine flavour intensity scores.*

> *The analysis of non-phenolic glycoside fraction in grapes by the G-G assay does not appear to provide an indication of wine flavour intensity.*

The automated robotic system for G-G analysis being constructed by an independent Adelaide firm, has had delays, due to a number of serious obstacles which were not anticipated when the system was first planned. This has been a major, complex, multi-step laboratory automation project and during the project's life numerous obstacles have been overcome to develop the system to its present state. Progress is still being made.

The G-G assay research will continue as part of the investigations into near infrared reflectance spectroscopy (reported above), which is hoped will allow rapid G-G analysis of samples and provide greatly increased ability to utilise the G-G assay as an indicator of potential and actual wine quality.

> *The Analytical Service is presently offering the G-G and grape colour analysis as part of their commercially based service.*

Black pepper aroma in Shiraz wines

In order to be able to understand and control the level of black pepper flavour in Australian Shiraz wines, a project has been started to attempt to identify the volatile compounds responsible for this distinctive aroma character. Shiraz grape berry samples with definite black pepper flavour have been obtained, together with a supply of grapes which do not display this flavour. Preliminary investigations have been carried out to assess suitable analytical conditions for identification of the aroma compounds responsible for the pepper aroma attribute, and small-scale winemaking and sensory experiments are being undertaken. Gas chromatography-olfactometry experiments have indicated detectable analytical differences between the peppery grapes and the non-black pepper berries, and work is in progress to identify the key compounds.

Evaluation of an aroma sensing instrument to differentiate grape and wine samples

So-called 'electronic chemical noses' are instruments that have an array of chemical sensors that respond to volatile compounds. These instruments give a rapid response with little or no sample preparation, have the potential to replace or complement sensory panels and could prove to be valuable in assisting with blending decisions, wine grading or quality control. They do not necessarily, however, give information regarding the concentration of specific components.

An instrument utilising a mass spectrometry based detector system is at present being evaluated to determine its possible use in industry and to complement existing technology at the Institute. The instrument is available through a successful ARC Research Infrastructure Equipment and Facilities Grant to the Department of Horticulture, Viticulture and Oenology, The University of Adelaide (Dr Graham Jones): 'Facility for the chemical analysis of food, beverage and plant aromas', in which the Institute was a partner. Preliminary assessments of the chemical sensor have suggested that it has potential to differentiate wines on the basis of volatiles in the headspace, and further work will be carried out with grapes and grape extracts, as well as taint compounds.

Development of an accurate, rapid analytical method for the quantification of key wine flavour compounds

This project has the overall aim of establishing the identity and development of accurate quantification methods for the specific volatiles that are most important to wine flavour.

The project has firstly involved the synthesis of stable isotope analogues of a number of known potent grape-derived aroma compounds. In particular the flavour compounds -damascenone (considered to be cooked apple-like or honey-like in aroma), - and -ionone (berry, violets), and 2-methoxy 3-isobutylpyrazine (vegetative, capsicum-like) have been targeted initially. The isotopically labelled compounds are relatively straightforward to synthesise, the methods having been developed by George Skouroumounis, and to date labelled analogues of -damascenone and -ionone have been produced, as a result of the work of the newly appointed Josephine Newton.

The isotopically labelled analogues will be used as internal standards to develop a relatively rapid, accurate and precise GC/MS analytical method for quantification of important flavour compounds in grapes, juices and wines, similar to the methods that have been developed for oak derived flavours and cork taint compounds. In a complementary aspect to this work, isotopically labelled analogues of fermentation-derived flavour compounds have also been prepared, to allow a more comprehensive analysis to be performed on wine volatiles. This approach of appraising carefully the changes in yeast derived esters and alcohols will enable assessment of the interaction of grape composition and yeast fermentation on wine flavour compounds.

Further work will be carried out to formally confirm the role of each of these compounds in wine aroma, using sensory methods, and future studies will accurately and precisely quantify the levels of these and further compounds in a range of grapes and wines, and assess the impact of viticultural and oenological variables on their concentration.

The influence of oak cooperage on wine composition

Staff: Mark Sefton, Alan Pollnitz and Dimitra Capone

Analysis of volatile oak components in wine

Following some 'fine tuning' of the program to develop new analytical methods using Stable Isotope Dilution Analysis for determining volatile oak-derived flavour compounds in wine and oak (see previous annual report), this has now been completed.

The method has been used to determine the concentration of 4-ethylphenol in red wines from an industry barrel trial, and also in a range of bottled products.

> *The red wine samples so far examined contained 4-ethylphenol, ranging in concentration from 2 μg/L up to 4500 μg/L.*

In the industry barrel trial, 4-ethylphenol was measured in red wine taken from 46 American oak barrels and 47 French oak barrels.

> *Oak origin (i.e. seven different French oak barrel suppliers and six different American oak suppliers) had little effect on the level of 4-ethylphenol found in the wine. (Mean 4-ethylphenol concentration was 460 μg/L in the French oak wines and 440 μg/L in the American oak wines).*

> *There was no significant difference between the 4-ethylphenol concentration of wines aged in fine or medium grained oak.*

For the French oak barrels, the age of the barrels used had no significant effect on the amount of 4-ethylphenol found in the wine. Shaved and re-fired three-year old barrels had 20% less 4-ethylphenol (mean concentration, 401 μg/L) than did unshaved three year old barrels (mean concentration, 514 μg/L).

For the American oak barrels, the wine in the new and one-year old barrels had a mean concentration of 4-ethylphenol of 201 μg/L and 391 μg/L respectively. Two- to four-year old barrels had a mean concentration of 541 μg/L, with no significant difference between two-, three- and four-year old barrels. Shaving and firing the four-year old barrels resulted in a substantial decrease in the concentration of 4-ethylphenol in wines aged in the barrels.

> *The mean concentration of 4-ethylphenol in these shaved barrels was 95 μg/L, less than half the concentration found in wine in the new barrels.*

> *An analytical service for oak components in wine and oak extracts is now available to Industry.*

> *Winemakers using the service have shown a particular interest in determining 4-ethylphenol in red wines.*

> *Investigation of several wines perceived to be of poor quality by producers, has shown the presence of a high concentration of 4-ethyphenol.*

Effects of heating on extraction of flavour compounds from oak

Experimental work for a study, part of which was carried out in collaboration

From left: Gayle Baldock, Yoji Hayasaka and Stella Kassara

with a student of The University of Adelaide, on the effect of heating temperature on the composition of oak, and on the rate of extraction of volatiles from the oak has been completed. The study has used both fine shavings and whole pieces of oak, heated to precisely controlled temperatures in a laboratory oven. Samples were taken from replicate staves from each of several oak stacks, and from different sections from within each of the staves. The initial aim of this study was to investigate apparently conflicting reports in the literature on the effect of barrel-toast levels on oak lactone extraction into wine.

The greatest variation in oak lactone content was between individual staves from the same oak stack, illustrating the need to sample several staves when assessing the favour potential of a particular wood-lot. There was a comparatively small variation in oak lactone concentration along the length of the stave.

Oven-heating of sections from each stave had little or no effect on the total extractible oak lactone obtained from the samples. However, a study of the rate of evolution of oak lactone from these heated sections into a model wine showed that the heating process significantly slowed the rate of extraction. Thus, approximately 0.9% of the total oak lactone in an unheated section of wood from an Allier stave was extracted after one month, whereas only 0.35% was extracted from a section heated to 225°C.

> *Toasting oak barrels slows the rate at which wine will extract oak lactone from those barrels.*

With oven heating, the concentration of most volatile oak components increased uniformly through the depth of the stave with increasing heating time and temperature. However, the increase in vanillin concentration was greatest on the surface of the stave. It is possible that contact with air during the heating process was responsible for this observation. This possibility is now being tested with oak shavings heated in the presence and absence of air.

> *Preliminary results indicate that the presence of air more than doubles the amount of vanillin formed when oak shavings are heated.*

Studies on unstable wine proteins involved in haze formation

Characterisation of unstable proteins involved in haze formation

Staff: Elizabeth Waters, Ken Pocock, Shauna Brown, Miguel de Barros Lopes and Peter Høj
The University of Adelaide staff: Robyn van Heeswijck (through UA 96/1) and Kathryn Adams (through UA 96/1)

Examination of the effect of different viticultural practices on the composition of unstable protein in grapes

We have confirmed the previous conclusions described in the 1997/98 Annual Report by examining the concentration of the unstable protein complement (PR proteins) of Shiraz berries from two years of an irrigation trial conducted by Dr Mike McCarthy (South Australian Research and Development Institute). This work was presented as a poster at 10AWITC and has been submitted for publication.

> *Apparent unstable wine proteins are not 'turned on' by water stress but the associated berry shrivel can result in higher protein concentration in the juice.*

Determination of biochemical properties of the PR proteins

This work has been completed and published (Institute publication 583).

> *There are multiple genes for the unstable wine proteins.*

> *Some limited proteolysis of the chitinases, a class of 'unstable' wine PR proteins, occurs naturally during crushing and fermentation.*

Evaluation of a method for the varietal discrimination of wines based on their protein composition

Since subtle differences between the molecular weights of proteins are readily detectable by electrospray mass spectrometry, it may be possible to identify cultivars, and possibly even clones by the protein profile of berries, must and wine. Such an identification technique would complement and extend the identification service currently available, since DNA fingerprinting is possible for berries and must only, as DNA is degraded during fermentation. This possibility is being explored as a collaborative effort with the Department of Horticulture, Viticulture and Oenology, The University of Adelaide (through UA 96/1). The ability to identify the contributing varieties post-fermentation may serve to further enhance label integrity worldwide.

The profiles of molecular weights of proteins in the juice of 19 different varietals harvested in 1998 from the Waite Campus vineyards were determined by LC-ESI-MS and showed significant differences. These preliminary results were disclosed in a poster at the 10AWITC. Juice samples stored from the 1997 harvest and grapes from the 1999 harvest from this same vineyard have now also been assessed. Encouragingly, but not surprisingly, differences in the protein profiles between varieties appear consistent from year to year. Further juice samples of selected varieties from different regions from the 1999 harvest will be examined in the next few months to confirm that differences in proteins from different varieties can be consistently seen across regions as well as years.

> *Small differences in gene sequences among varieties of wine grapes can be detected by ESI-MS of PR proteins, the gene products.*

> *Expected outcome is technology to further secure compliance with state, national and international regulations in regard to label integrity.*

Evaluation and development of alternative methods for protein removal from juices and wines

We are collaborating with our colleagues at the Department of Horticulture, Viticulture and Oenology, The University of Adelaide and the Department of Chemical Engineering, University of Melbourne on this objective.

It is believed it would be prudent to re-examine heat treatment, combined with proteolytic enzymes, of juice and wine. Previous work at the Institute and elsewhere has shown that juice and wine proteins appear resistant to proteolytic attack at temperatures below 25°C. At higher temperatures, other groups have reported losses of proteins and reduced bentonite requirements for juices and wines treated with proteases. Some of these losses appear to be due to the heat treatment alone. Nevertheless, proteases are not used and the use of heat treatment is not widespread in industry, possibly due to the perception that heating under any conditions is detrimental to wine quality. This appears to be unfounded, at least in some cases, because previous work at the Institute showed that short time (2 or 10 min)/high temperature (~90°C) treatment had no clear sensory effect on wines and that heating at lower temperatures for longer periods may even have been beneficial (Institute publication 444). Plans to evaluate heat treatment of wine alone and in conjunction with proteases are underway. Preliminary work by Kathy Adams, Department of Horticulture, Viticulture and Oenology, The University of Adelaide, is very encouraging.

Expected outcomes:

> *Stabilisation of white wines with novel methods to remove protein.*

> *Reduction or elimination of bentonite addition to wines, and therefore problems with bentonite disposal, and potential loss of wine volume and flavour.*

Haze protective mannoproteins (HPF)

The haze protective factor (HPF) offers a potential alternative to fining to control wine protein stability. HPF is a yeast cell wall mannoprotein, discovered at the Institute in 1991 (Institute publications 439, 443, 460, 464, and 471), that interacts with unstable proteins to apparently prevent haze formation. The mechanism of action of HPF is not to prevent protein precipitation *per se*, but to change the manner in which haze is formed, such that the size of the haze particles is lower when HPF is present. This has the visual effect of decreasing the turbidity of the wine without preventing protein from necessarily aggregating.

The majority of the work on this project has been done by students, Dr Isabelle Dupin and Ms Vanessa Stockdale. Isabelle received her doctorate in 1997, and Vanessa is currently writing up her thesis. Isabelle identified HPF as a yeast cell wall protein. Vanessa has identified two structural genes for HPF-like material. The project now enters the molecular biology phase. Future work will be undertaken in collaboration with Dr Miguel de Barros Lopes, our Molecular Biologist, as part of the PhD program of Ms Shauna Brown. Shauna commenced at the Institute on February 15 1999. A bid to augment this project through collaboration within the CRC For Biopolymers has been successful and a post doctoral fellow to work with Professor Tony Bacic (University of Melbourne) on the physiochemical basis for HPF action has been appointed.

The genes encoding putative HPF are being cloned and attempts will be made to construct a strain which over-expresses and secretes HPF.

Expected outcomes:

> *Yeast strains that over express HPF: a high yielding source of HPF for further evaluation.*

> *A more general understanding of and tools for the efficient secretion of proteins in yeast.*

From left: Shauna Brown, Elizabeth Waters and Ken Pocock

Studies on random oxidation of bottled wines

Staff: Elizabeth Waters, George Skouroumounis, Zhong-Kui Peng

Development of rapid assays to measure oxygen permeation into wine

A major effort in this reporting period has been to develop a rapid and simple method to measure oxygen permeation through corks into wine bottles when filled with

liquid. A rapid method is needed as currently we can only indirectly measure oxygen permeation, and this is done by bottling wine and waiting six to 12 months before performing analyses to determine SO_2 levels. This process is slow, the analyses are expensive and, due to the complex nature of wine, cannot be directly related to the quantity of oxygen entering the bottle.

A range of compounds has been identified as candidates for an oxygen assay from an extensive survey of the literature. All of those investigated to date have been inappropriate for use in wine. Developing an appropriate assay is a difficult task because, apart from being able to measure oxygen at low pH in the presence of ethanol (the conditions the cork is expected to perform under), the system must be able to cope with the relatively large amount of oxygen entering the bottle from the initial outgassing of the cork upon its insertion, and then still be sensitive enough to the small amount of oxygen that constantly permeates in. The development of this technology would enable us to measure oxygen ingress into filled bottles, a more realistic measure than that of dried corks which probably allow a higher rate of ingress.

Our collaborators at CSIRO Food Science and Technology have mounted an oxygen sensor within a bottle and can measure oxygen transfer through a cork inserted in the bottle neck. Due to equipment limitations, only five corks can be tested in one two-monthly session. Nevertheless, this approach is the method we will use if a rapid chemical method cannot be developed within six months.

Identify winemaking techniques contributing to random oxidation of bottled wines

It is possible that particular winemaking techniques add to the random oxidation problems caused by corks. A re-examination of work conducted some years previously in this project and its subsequent finalisation and publication (Institute publication 577) has suggested that ascorbic acid addition to wines could be making such wines more susceptible to browning. In addition, there have been reports from Industry that upright storage of bottles exaggerates the oxidation problem.

A trial to examine the effect of ascorbic acid and bottle position on oxidation and sensory characterisation is now being carried out in collaboration with Mr Blair Duncan, Southcorp Wines. A wooded Chardonnay wine will be bottled with and without ascorbic acid addition, sealed with two peroxide washed cork types and stored either on the side or upright for up to two years. Regular *in situ* measurements of the degree of browning of every bottle will be made by measuring absorbance at 420 nm without removal of the cork. All planning for this trial was completed and bottling took place in August 1999. Future expansion of the project will address the effect of wine type and oxygen concentration on the role of ascorbic acid in wine browning.

> *Industry practices that may decrease the extent of oxidation in wines caused by permeation of oxygen through corks could be an outcome of this research.*

The prevention of cork taint in wine

Staff: Mark Sefton, Yoji Hayasaka, Alan Pollnitz and Dimitra Capone

The transmission of TCA (2,4,6 trichloroanisole) from external sources through corks in bottled wine

An experiment to determine whether TCA from external sources can penetrate wine corks in bottled wines and, thus, taint the contents has been completed. One thousand nanograms of deuterium-labelled TCA had been added to the top of the corks of more than eighty bottles following closure. The corks (both natural and agglomerate) were obtained from a variety of suppliers, and had a variety of bleaching treatments. The majority of corks were placed in the bottles immediately prior to the start of the experiment, but some bottles were commercial products that had been bottled up to 20 years previously.

No deuterium-labelled TCA was detected in any of the wines, which were analysed more than two and a half years after addition of the TCA to the outside of the cork (the limit of detection was < 1 ng/bottle). The corks from the bottles were dissected into three sections and these sections have also been analysed. Of the deuterium-labelled TCA originally added, less than a third remained in the corks; the rest had apparently been lost to the atmosphere. No more than trace quantities had reached the bottom third of any of the corks. There was no significant difference between old and new corks in their effectiveness as a barrier to the transmission of TCA.

TCA was found in some of the wines, but this did not contain the deuterium label and had, therefore, been derived from endogenous TCA already present in the corks. Such unlabelled TCA was also found to be distributed through the cork. This demonstrates the necessity of using the labelled analogue in this type of experiment. Had unlabelled TCA been added to the outside of the corks at the beginning of the trial, in some bottles, this would have been found throughout the cork and in the wine, and a false inference might have been drawn regarding the ability of corks to transmit TCA.

> *Corks constitute an effective barrier to the transmission of TCA. This means that wines in bottles sealed with cork closures and stored in an environment contaminated with TCA will not, themselves, become contaminated in the short to medium term (< 3 years) unless the corks already contained TCA prior to closure.*

Absorption of airborne TCA by wine corks

In order to test the ease with which a source of TCA, not in direct contact with corks, could contaminate such corks via the vapour phase, samples of filter paper impregnated with deuterium-labelled TCA were placed in enclosed glass tanks containing corks suspended in wire mesh, so that no cork was in direct physical contact with the source of the contamination at any stage of the experiment. The deuterium-labelled analogue was used in order to distinguish TCA absorbed during the experiment from any endogenous (i.e. unlabelled) TCA that might have already been present in the corks.

From left: Alan Pollnitz, Dimitra Capone and Daniel Sejer

The corks were able to absorb the labelled TCA from the atmosphere rapidly, reaching equilibrium in a matter of hours under the experimental conditions employed. A commercially applied surface treatment had no effect on the ingress of the TCA into the corks. Dissection of sample corks showed that most of the absorbed TCA was localised in the outer 2 mm of the cork cylinder, but a significant proportion (circa 15%) migrated to the interior of the cork after as little as 24 h exposure. The distribution of the TCA between the outer 2 mm and the inner part of the cork had changed insignificantly after prolonged exposure (35 days) to the atmospheric TCA. No differences in labelled TCA levels between the younger and older growth rings of the corks was observed.

Aeration, over an extended period, of corks heavily contaminated with the labelled TCA resulted in a gradual loss of this compound. Little change was observed after 14 days of aeration, but after 63 days, up to 80% of the labelled TCA was lost from the corks. Although it would seem that the extensive period of time required for this procedure to have a significant and beneficial effect is impractical in a commercial setting, the observation that TCA can be desorbed in this manner, suggests that aeration, albeit under modified conditions, may yet prove useful in improving the quality of wine corks.

> *This study confirms that corks can easily absorb TCA from a contaminated atmosphere without direct contact with the source of contamination, and that such uptake can be rapid in the context of typical transport and storage times.*

Alternative screening methods for TCA

Preliminary work has commenced on investigating the use of 'electronic nose' technology as an alternative method for screening batches of cork for possible TCA contamination.

The structures, rates of formation, and sensory properties of red wine tannins and the influences of viticultural practices on these tannins

Staff: Elizabeth Waters, George Skouroumounis, Zhong-Kui Peng, Leigh Francis, Ken Pocock, Yoji Hayasaka, Stella Kassara, Anita Oberholster, Gayle Baldock

The University of Adelaide:
Graham Jones, Pat Iland, Richard Gawel, Robert Asenstorfer

The Industry Reference Group (IRG):
The IRG, comprising personnel from the following industry members: *Balnaves of Coonawarra* (Peter Bissel), *BRL Hardy* (Steve Pannell), *Boars Rock Winery* (Michael Farmillo), *Henschke Wines* (Stephen Henschke), *McWilliam's Wines* (Jim Brayne), *Mildara Blass* (Nigel Dolan), *Moss Wood Winery* (Keith Mugford), *Nepenthe Wines* (Peter Leske), *Orlando Wyndham* (Peter Gambetta), *S. Smith & Son* (Simon Adams), *Southcorp Wines* (Peter Taylor), *Wine Network Australia* (Gary Baldwin) and *Wirra Wirra* (Ben Riggs), met in February and was presented with details of two winemaking subprojects. A tasting of the experimental wines was also conducted (see progress report below). We consider this interaction with senior winemakers is of great mutual benefit.

The background to this highly collaborative project with The University of Adelaide was outlined in The 1997/98 Annual Report. Progress has been made on a number of fronts in this very difficult area of research and only the recent highlights will be outlined here.

Development of sensory methods to determine the structure of monomeric, oligomeric and polymeric pigments and procyanidins in wines

Mass spectrometric methods to characterise pigments and tannins are being further developed and refined. Investigations using electrospray ionisation (ESI) with grape seed procyanidins (tannins) have given promising results. This work was presented as a poster at the Tenth Australian Wine Industry Technical Conference and will be submitted as a formal paper in the second half of 1999. An alternative mass spectrometry technique for structural characterisation, matrix assisted laser desorption ionisation time of

flight (MALDI-TOF), has been evaluated but appeared not to offer any clear benefits over the ESI instrument in the facility at the Institute.

Methods to fractionate wine tannins and polymeric pigments, using thin layer chromatography (TLC) after preparative scale normal phase chromatography have also been developed by The University of Adelaide staff and Institute staff. Progress in this area is important because reasonable quantities of fractions of the pigments and tannins are needed in order to characterise them sensorily and chemically.

Conference and two manuscripts describing this work have been submitted for publication. A review of the literature by Richard Gawel, DHVO has also been published (Gawel, R. Red wine astringency: a review. Aust. J. Grape and Wine Research 4:74-95 1998). It is hoped that this work and the publication of a prototype 'mouthfeel wheel', in the style of the 'Noble' aroma wheel, will facilitate the Industry's ability and researchers' ability to evaluate the outcomes of winemaking and research trials using a common language.

differing viticultural areas and made into wines. Temperature and added SO_2 regimes were the winemaking parameters we varied. Preliminary data shows that vitisin formation occurs during both fermentation and maturation with the fermentation phase being the key step to their formation. Increased levels of bisulphite increase the amount of vitisins produced during maturation. Viticultural parameters may also affect the amount of vitisins formed with higher quality grapes yielding higher levels of vitisins in the finished wines.

From left: George Skouroumounis and Mariola Kwiatkowski

Expected outcome

> *An understanding of the structure and size of tannins that are important to wine tannin composition.*

Development of methods to evaluate the sensory properties of monomeric, oligomeric and polymeric pigments and procyanidins in wines

Significant progress towards this objective has been achieved. The results were presented to Industry as a poster at the Tenth Australian Wine Industry Technical

> *A set of attribute terms which are relatively specific and definable is now available for description of tannins.*

> *A trained group of panellists who are able to use these methods and terms in a reproducible manner is available for tannin research.*

Development of methods to understand the formation of oligomeric pigments (vitisins) in wines

Experiments involving the making of mini lot wines have been conducted to investigate the factors affecting the formation of these types of stable colour compounds. Grapes of different varieties, but principally Shiraz, were sourced from

Elucidating the factors required for formation of polymeric pigments in wines

One of the mechanisms for the formation of wine polymeric pigments postulated in the literature, interflavan bond breaking and bond making, was investigated in the last 12 months. Following a literature procedure, seed procyanidin (tannin) and malvidin-3-glucoside (the dominant red pigment in grape skins) were isolated, added to four different white wines and incubated for up to one month at room temperature, together with the appropriate controls. The formation of pigmented polymeric material occurred to varying but low extents in the samples, including those with very low initial procyanidin levels and without added procyanidin. This data suggested that pigmented polymer formation due to the incorporation of malvidin-3-glucoside into existing colourless seed procyanidins was not occurring to a significant extent after fermentation. As this result is in contrast to published work, the reactions were repeated and the data was confirmed.

We have begun work on acetaldehyde induced procyanidin/anthocyanin addition reactions. There is good evidence in the literature that polymerisation of phenolic compounds can occur under wine-like conditions through this condensation mechanism. We plan to isolate and characterise the model polymeric pigments, to confirm that this mechanism occurs to a significant extent in wines.

> *Model studies carried out in our laboratory have confirmed that acetaldehyde is important for polymeric pigment formation. It is being investigated whether this is also true for 'real' wine.*

Expected future outcomes

> *A knowledge of the structures of wine pigments and an understanding of the processes whereby they are formed in wine.*

> *Directions for future research on the winemaking practices likely to have the greatest influence on tannin structure.*

Accumulation of anthocyanins and procyanidins in grapes

Analysis of berry samples collected from Shiraz vines grown at the Nuriootpa Viticultural Research Station during the 1997 and 1998 vintages showed that, during ripening, the levels of seed catechin and epicatechin decreased significantly, while seed procyanidins (tannins) decreased slightly. Anthocyanins accumulated in the early to mid ripening stages and then tended to plateau during the later stages of ripening.

Analysis of seed samples from Shiraz grapes sourced from a range of irrigation experiments during the 1998 vintage are currently being assessed. This work is currently being written up for publication and was presented as posters at the Tenth Australian Wine Industry Technical Conference.

Tannin structure and sensory aspects of wine

Eleven wines from the 1997 vintage, representing Shiraz grown in five different viticultural regions (and with different management practices) were used in the sensory studies to test the attribute terms used to describe mouthfeel.

> *The terms dusty, powdery and drying were used more often to describe wines from cooler viticultural regions, while velvet, silky, chamois and watery were regularly used to describe wines from warm to hot viticultural regions.*

Another set of six Shiraz wines from three of these regions were made in 1998 and will be used to further develop and verify mouthfeel descriptors and their relationship with grape and wine composition.

Expected outcomes

> *An understanding of the impact of different viticultural practices on tannin formation and the mouthfeel properties that these tannins impart to wines.*

> *Recommendations to Industry for viticultural practices to produce grapes of a defined quality and end use.*

Establishing the influence of winemaking practices on the tannin structure and sensory aspects of wines

The major effort on this objective is not scheduled to begin until a better understanding of tannin formation is available. Nevertheless some work has been conducted on two winemaking aspects: the role of seeds and the addition of exogenous tannins. The preliminary experiment conducted on the impact of seeds on the tannin profile of wines using frozen grapes in 1997 has been repeated using fresh fruit. Although all the data have not yet been analysed and the wines need to undergo sensory evaluation, it appears, not unexpectedly, that adding extra seeds to the ferment produces wines with increased levels of phenolics, including tannins and pigmented polymers, and more colour. This work was presented as a poster at the Tenth Australian Wine Industry Technical Conference.

Tasting by the IRG in February of the wines made with the normal complement of seeds, and with extra seeds, indicated that the wines made with extra seeds were more tannic (similar to the effect of adding exogenous tannins) and likely to perform better in the long term than the wines made conventionally. A formal tasting with a trained panel will be conducted later in the year.

As part of this work on the role of seeds, some characterisation of seed tannins from Shiraz and Pinot Noir grapes has been done. Evidence obtained from investigations using spectrophotometry, ESI mass spectrometry and thiolysis have all consistently shown

> *that there is a greater degree of galloylation of tannins in grape seeds from Shiraz than of that from Pinot Noir. This is significant because galloylation is believed to increase the astringency of tannins.*

In addition, the ratio of the amount of monomeric phenolics to procyanidins in Pinot Noir seeds is higher than that in Shiraz seeds. This may also effect the sensory properties of wines because monomeric phenolics are held to be more bitter than astringent.

The effect of added exogenous tannins on the polyphenolic levels in red wine was carried out as an honours student project by Emma Wood, in Dr Graham Jones' (The University of Adelaide) laboratory. Small lot wines have been made from grapes of medium or high quality. Either a hydrolysable or condensed tannin were added to the wines. For wines made from grapes of higher quality, the addition of either exogenous tannin had negligible effect on the total polyphenolic content or the colour of the wines after three months of storage. On the other hand, the addition of condensed tannin to the wines made from lower quality grapes enhanced the total polyphenol levels in the wine after three months of storage and gave an increase in red colouration of the wines.

Expected outcomes

> *An understanding of the different winemaking practices that may be used to manipulate the tannin composition and the mouthfeel properties that these tannins impart to wines.*

> *Recommendations to Industry for winemaking practices to produce wines of a defined quality and end use.*

Waite Campus Mass Spectrometry Facility

Staff: Yoji Hayasaka and Gayle Baldock

The four 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; 3) as a collaborator with The University of Adelaide in research and teaching activities involving mass spectrometry; and 4) as a provider of versatile and advanced mass spectrometric techniques and related expertise to the scientific community including public as well as private institutions.

Usage of the gas chromatograph-mass spectrometer (GC-MS) and electrospray mass spectrometer (ESI-MS) on a time basis by individual groups were 58% and 57% for AWRI, 38% and 19% for The University of Adelaide, and 4% and 24% for other groups including Flinders University, CSIRO and private companies. Appropriate financial arrangements for all users are in place to recover the running cost of the Facility, and an additional payment is required for non-levy payers and private institutions to recover expenses incurred by staff of the Facility for mass spectrometric analysis and interpretation.

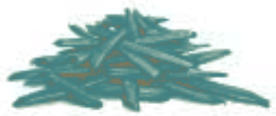
Ongoing research on the characterisation and quantification of tannins, anthocyanins, flavour volatiles and grape and wine proteins using GC-MS, ESI/MS, LC-ESI/MS and nanospray-MS, as well as their MS/MS techniques, was carried out in collaboration with the Research Team members and students of the Institute, and the Department of Horticulture, Viticulture and Oenology, The University of Adelaide. It is particularly noted that ESI-MS has considerably enhanced the progress of tannin and protein projects detailed elsewhere in this report.

This Facility conducted fourteen cases of problem solving work in collaboration with the Industry and Analytical Services Teams. The role of chemical analysis by mass spectrometry is to identify and quantify the taint materials causing undesirable impact on grape, wine and related products, as well as to investigate the cause of problems. The types of problems encountered were cork taint (three cases); contamination with paints, styrene, and unknown (two cases each), and plastic sheet, epoxy resin, chlorophenol, haze and 4-ethylphenol (one case each).

> *The Institute is increasingly relying on advanced GC-MS and LC-MS analyses for investigating Industry taint problems.*

Due to the negative properties of ethyl carbamate (urethane) many export markets have introduced low allowable limits for this compound in foodstuffs, including wine. It is essential, therefore, that the Australian Wine Industry has available to it methods for measuring ethylcarbamate in wine.

> *A GC-MS based method for the accurate analysis of ethyl carbamate at low ppb levels in wine has been established. This analyses is now offered by the Institute's Analytical Service.*



Industry Services Teams' reports

From left: Peter Godden and Wies Cynkar

A wide variety of mass spectrometric analysis and consulting services were carried out for the Departments of Horticulture, Viticulture and Oenology, Plant Science, Biochemistry, Geology and Zoology, The University of Adelaide as well as schools of Bioscience and Physical Science, Flinders University. Mass spectrometric services have been provided to several private companies on a commercial basis.

As part of the wide-ranging Institute reorganisation, the name of the former Technical Services Group was changed to 'Industry Services Team'. In addition, direct management of the Analytical Service and of the John Fornachon Memorial Library, was removed from the Group, solely to allow the Manager to provide a higher quality service to industry in his area of expertise in a rapidly growing industry with many new practitioners. The Industry Services Team provides a range of advisory, problem solving and information services to the Australian Wine Industry, and the physical resources utilised comprise the Industry Services Laboratory, part of the Trace Analysis Laboratory (formerly the Agrochemical Residue Laboratory) and tasting facilities. The Team exists to provide information and technical assistance to the Australian Wine Industry, and in particular its winemakers, through the services described below.

Technical problem solving and consultation

Staff: Peter Godden, Adrian Coulter, Mark Gishen, Peter Graves, Peter Valente and Nick Bruer (until 18 December 1998).

The provision of problem-solving analysis and advice to Australian winemakers represents a significant proportion of the workload of the Industry Services Team. The Laboratory analyses several hundred wine samples each year (Table 1), using a wide range of routine and unique analytical techniques, supplemented by detailed sensory evaluation by a panel of experienced tasters. The aim of the service is to offer remedial and preventative advice based on the cumulative problem solving experience of the staff, and the Team Manager's and Oenologist's practical winemaking experience, rather than providing a simple diagnosis of the cause of the problems. Increasingly, staff see themselves in an educational role, seeking to disseminate information in a variety of ways, in order to prevent the recurrence of particular types of problems. The Industry Services Team also provides technical support to the Institute's Analytical Service, particularly in the areas of contract trial-winemaking services, and the interpretation of analytical results. After twelve years as a pivotal and highly valued member of the problem-solving service, Oenologist, Nick Bruer, left the Institute in December 1998, to pursue a career in winemaking.

Confidentiality is an important aspect of such services, and is strictly maintained in all cases. When a particular problem is considered to be of interest to the wider industry, the results of investigative work may be made available through relevant publications, but under no circumstances is the name of the winery, or any possible identifying reference, revealed.

A summary of the number and type of samples received by the Industry Services Team over the past three financial years is presented in Table 1. The total number of samples received during the year shows an eighteen per cent decrease on the previous two years. While continued Industry support for the services provided is welcome, it is also pleasing to note that there has been a decrease in the number of samples received in the combined and related areas of hazes and deposits and microbiological instability. Whilst it is difficult to draw conclusions regarding the reasons for this decrease, Industry Services staff have placed particular emphasis on highlighting the issues related to these areas of wine instability during the past two years. This has been done through the publication of articles in the Institute's *Technical Review*, presentations and

distribution of relevant literature at Roadshows, and a presentation at the Tenth Australian Wine Industry Technical Conference. In addition, this area will be the first addressed by a new GWRDC-funded project, the *Targeted training of wine industry personnel: compilation of a technical reference manual,* which will commence during the coming year, and be coordinated by the Industry Services Team.

However, despite the downward trend in the frequency of this type of investigation, a substantial number of wine samples continue to be received with microbiological instability, often resulting in a haze or deposit having formed after bottling. Many of these wines have a high pH level, a low concentration of sulfur dioxide, and in some cases it is apparent that the primary or malolactic fermentations are incomplete. Commonly, these wines have been subjected to a minimal level of filtration.

The number of samples submitted with closure-related problems has shown a marked decline, and this is another area in which Industry Services staff have been highlighting the issues for many years. The decline in the number of samples may merely indicate that industry practitioners now recognise and can deal with this type of problem themselves, rather than that the scale of the problem has diminished. As foreshadowed in the previous Annual Report, a major comparative trial to examine the technical performance of various types of wine closure, has now commenced. Details are provided later in this report.

The types of investigations recorded in Table 1 as 'other investigative analyses' are extremely varied. Examples of the work carried out this year are: evaluations of wine additives, such as tartaric acid and bentonites, for regulatory compliance; analysis of a fortified wine with a high pH level, which required an unusually large addition of bentonite to render it protein stable; analysis of the oxalic acid content of wines from a particular vineyard/winery, which had proved to be calcium-tartrate unstable in previous vintages; and analysis of a wine in which calcium-tartrate instability seemed to have been conferred by fining with calcium-caseinate.

Winemaking consultation

The Industry Services Team provides a winemaking consultancy service principally through the Manager, Peter Godden, a qualified and experienced winemaker; the Oenologist, Adrian Coulter; and Mark Gishen, the Institute's Quality Liaison Manager. Peter Godden expanded his winemaking experience during 1998, particularly in the area of making wines from the variety Sangiovese, by working during vintage in Italy, with the company Antinori. This was in response to a dramatic increase in the number of Australian grapegrowers and winemakers requesting information relating to growing, and producing wine from, Italian grape varieties.

Most queries are technical in nature and arise from Australian winemakers. However, many general queries are also received from Government bodies, the general public, and secondary and tertiary students. Where appropriate, the query is answered over the telephone, by facsimile or by e-mail. Industry Services staff supply approximately five hundred technical papers or other pieces of relevant literature to callers each year. More complex cases are solved with winery visits and the support facilities provided by research and Library staff. The analytical capacity of the Industry Services Laboratory plays an important role in responding to many of these enquiries and increasingly advanced mass spectrometric analyses are employed to investigate 'problem' samples.

The Institute often acts as a referral service, having links to Australian and international wine research and political bodies. The vast store of information, both formal (in the John Fornachon Memorial Library) and informal, is a valuable resource to the wider industry.

A summary of the enquiries received by Peter Godden, Adrian Coulter, Mark Gishen and Nick Bruer during 1998/99 is presented in Table 2. The figures show an eight per cent increase in the number of enquiries received, compared to an average increase of approximately five and a half per cent in the previous two years. The trend towards a greater proportion of enquiries coming from wineries has continued. The number of calls received from government organisations returned to previous levels during the year, after a sharp increase in 1997/98.

The Consultation and Investigative and Advisory Services are supported by vineyard and winery visits and seminar tours to all major wine growing regions, generally organised in conjunction with local vignerons' associations. The Institute aims to visit each major Australian viticultural region through such formal visits and tours every second year, with routine shorter visits by key staff as opportunities arise–frequently in conjunction with industry events such as capital city Wine Shows, and seminars held by other industry bodies.

A formal, week-long, 'Roadshow' visit, comprising six of the Institute's most senior staff, was made to Western Australia in November 1998. A full list of industry visits and seminar events in which Industry Services staff participated during the year is provided in Appendix 1.

The tenth Advanced Wine Assessment Course was held in September 1998, and the eleventh in December 1998, giving another 60 participants the opportunity to test and improve their sensory evaluation performance. The demand for the Course continues to be strong, despite the fact that it has not been promoted or advertised, which is an indication both of the quality of the Course and the need for practical training of industry personnel away from their individual work environment. As in the past, Associate Judges for the 1998 Adelaide Wine Show were selected from Course participants, and the course continues to attract interest from the production, marketing, sales and educational arms of the industry, from all States of Australia, New Zealand, and the United Kingdom. The Institute is most grateful to Peter Leske (Nepenthe Wines) for his pivotal role in mounting the tenth and eleventh Advanced Wine Assessment Courses (the planned twelfth course was held in August 1999, and led by Peter Godden, Manager Industry Services).

Throughout the year, the Team Manager continued to serve on both the Organising and Program Committees of the Fifth International Symposium of Cool Climate Viticulture and Oenology, which will be held in Melbourne between the 16th and 20th of January 2000. The Team Manager is organising a session of the Symposium titled *Exploring the links between grapes, vines and wines,* which will include speakers from Australia, New Zealand and Italy. In addition, the Symposium will include a Quality Management workshop, which is being organised by the Quality Liaison Manager, Mark Gishen, with assistance from the Team Manager.

Table 1. Summary of the number and type of samples submitted to the Industry Services Team for problem solving during the past three years

Samples received	**1996/97**	**1997/98**	**1998/99**
Determination of haze, deposit, etc.	142	80	79
Microbiological investigations	66	88	48
Sensory assessments	106	74	52
Taint problems	49	133	117
Other investigative analyses	143	203	245
Closure-related investigations	319	266	154
Total	**841**	**844**	**695**

Note: In previous years, the category 'Closure-related investigations' was recorded as 'Cork-related investigations'. This change reflects the variety of closure-types now being used by the Australian wine industry.

Table 2. Enquiries received by advisory staff during the past three years

	1996/97	**1997/98**	**1998/99**
Wineries	769	853	980
Government organisations	76	114	70
Other	432	396	419
Students	44	33	35
Total	**1321**	**1396**	**1504**

From left: Peter Valente and Adrian Coulter

Evaluation of new analytical techniques and of processing aids for winemaking

Staff: Peter Godden, Adrian Coulter, Peter Valente, Mark Gishen and Nick Bruer (until 18 December 1998)

The Industry Services Laboratory maintains a GWRDC-funded project for the improvement and development of methods of wine analysis, and the evaluation of winemaking processing aids and additives. The evaluations take one of two forms: the relative performance of commercially available products or the evaluation of new materials marketed to the industry. Staff also provide analytical support to the

The Australian Wine Research Institute

Industry Services Teams' reports

Australian Wine and Brandy Corporation and the Industry through the coordination and conduct of surveys of aspects of wine composition.

A major comparative trial, which will examine the technical performance of various types of wine closure and define relevant performance specifications, has now commenced. The trial wine was bottled under commercial conditions in May, and the technical performance of fourteen closures will be examined. Included in the trial are: two types of natural cork; two different types of cork closure which contain a synthetic component; three closures manufactured using different extrusion processes; a closure manufactured from expanded styrene-plus other monomers; five moulded closures manufactured by different processes or from different materials; and a roll-on tamper-evident closure. Various aspects of closure performance will be examined, including those relating to each closure's physical characteristics, chemical analysis of the wine in order to examine sealing performance, and sensory analysis coupled with chemical analysis using GC/MS, to examine any effect the closures may have on wine aroma and flavour. In addition, a trial will be conducted in conjunction with the wine-marketing staff of The University of Adelaide, to examine wine trade and consumer acceptance of various closure types. The full trial protocol was published in the June 1999 issue of the Institute's *Technical Review* and in the *Australian Grapegrower and Winemaker* (Institute publication number 593).

During the year, the Industry Services team commissioned a new Perkin Elmer atomic absorption spectrometer. The instrument allows for most existing procedures to be fully automated, and it is envisaged that an in-built system of sample concentration, will significantly reduce detection limits for cations such as lead and copper.

A new procedure for identifying the Gram Stain-status of a range of bacteria was trialed during the year. In comparison to the procedure currently used, this procedure has the advantages of not using any of the staining solution usually associated with this test, and it is very simple to perform. However, some inconsistencies were found, based on current knowledge of the ecology of wine microorganisms.

During the growing season which preceded the 1999 vintage, weather conditions over much of Australia were conducive to the growth of the mould *Botrytis cinerea*. Consequently, many juice and wine samples were analysed by the Analytical Service to determine the activity of *laccase*, the main oxidative enzyme associated with this mould, using the Novo-test(R) *laccase* test-kit. Some discrepancies were noted between results obtained from certain red juice samples, and from wine made from those juices, such that *laccase* activity was identified in the wines but not in the juices. During an investigation by Industry Services staff, samples of fruit from the same vineyard were divided into two lots; berries with visual signs of *Botrytis* infection and berries without infection. Each lot was divided in two, half of the berries being macerated and the juice gently pressed, and the other half homogenised in a food processor. The *laccase* activity assay was then applied to all of the samples. Each lot was then inoculated with yeast, fermented to dryness, and the assay applied to the resulting wine. The results indicated that either when applied to red juice samples the assay may underestimate potential *laccase* activity, or that *laccase* is more active in wine than in juice.

> *The* laccase *assay provided a better indication of possible* laccase *activity in wine when applied to an homogenate, than it did when applied to red juice.*

With input from research staff, the following analytical methods have been validated during the year, to the standards required by the Institute's internal Quality System which is based on NATA requirements: determination of *cis* and *trans*-oak lactone, guaiacol and 4-methylguaiacol, vanillin and 4-ethyl phenol in wine and oak-wood products, by GC/MS; determination of Carbendazim and Pyrimethanil in grapes and wine by HPLC; measurement of alcoholic strength using a densitometer, following distillation; a colorimetric method for the measurement of alpha-amino nitrogen in white and red grape juice, by *Roche Cobas FARA* auto analyser; enzymatic determination of ammonia in red and white grape juice by *Roche Cobas FARA* auto analyser; determination of ethyl carbamate in white and red wine by GC/MS; and application of the Multi Residue Assay (MRA) for agrochemical-residue determination by GC/MS, to grapes.

Trace Analysis Laboratory (formerly the Agrochemical Residue Laboratory)

Staff: Peter Godden, Greg Ruediger, Kevin Pardon

As part of the Institute restructure, the title of the Agrochemical Residue Laboratory was changed to *Trace Analysis Laboratory*. The change was made in recognition of the range of analyses being performed by the Laboratory, which also now includes oak volatile components, chloroanisoles and chlorophenols, and ethyl carbamate.

The work of the Laboratory relating to the CRCV-funded trials which seek to elucidate the fate of agrochemicals during the winemaking process, remains part of the Industry Services Team and is nearing completion.

Methods development is an ongoing function of the Trace Analysis Laboratory, and during the year the Multi Residue Assay (MRA) for the determination of agrochemical residues, was extended from wine to grapes. In addition, the MRA for wine was granted NATA accreditation.

During the year, work has progressed in collaboration with Dr John Skerritt, formerly of CSIRO Plant Science and Alex Sas, to develop ELISA-based test kits for the determination of agrochemical residues in grapes and wine. The Laboratory has conducted further analysis of samples for the validation of test kits for several commonly used agrochemicals, including carbaryl, iprodione, metalaxyl, triadimenol and carbendazim

Work on CRCV-funded trials examining the fate of agrochemical residues during the winemaking process and subsequent wine storage, is nearing conclusion. During the year, samples for the 'storage trial' were analysed at the twelve-month interval, and the red and white primary-fermentation and malolactic fermentation trials, have been completed. The protocol for the malolactic fermentation trial was expanded to include analysis of the fermentation lees, and the white wine primary-fermentation trial was expanded to include juice settling. Fruit for the red and white wine primary fermentation trials, was sourced from an organically managed vineyard, so as not to contain a background level of residues. The bunches were then individually sprayed with the agrochemicals which are the subject of the trial.

The continued assistance of the Institute's Viticulturist, Alex Sas, in the interpretation of analytical results and liaison with CSIRO and the viticultural and agrochemical supply industries, is gratefully acknowledged.

Quality Liaison Manager

Staff: Mark Gishen

The major output of the Institute's activities in the provision of advice on quality management techniques to industry remains the *From Grapes to Glass* program, which was published in August 1997. Two more companies have undertaken the program, with one of these already successfully obtaining certification. One other company from an earlier group has also been successful in attaining independent third party certification.

> *The* From Grapes to Glass *kit has now been enhanced to incorporate a HACCP-type (hazard analysis and critical control point) quality and safety plan that will encompass the requirements of the proposed changes to the food hygiene regulations, and meet the needs of the smaller scale businesses in the industry.*

This was achieved through a development program undertaken with the cooperation of a small to medium sized winery and included all aspects of the operation from grapegrowing through to bottling. The resulting draft program was further developed in a pilot project with a group of wineries in Victoria with some financial assistance from Business Victoria. The resulting model provides a simpler and cheaper 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.

The national food hygiene regulations (Food Safety Code) that have been proposed by the Australia New Zealand Food Authority (ANZFA) may have significant impact on the wine industry. It appears that all wineries will need to comply with registration requirements soon after proclamation of the legislation, and will eventually need to have a HACCP-type food safety program in place. The Institute has prepared a draft guideline for the industry to help explain the requirements and impact on the industry. ANZFA have offered to help review this document and their cooperation will be sought in finalising the guideline. As part of the development of the HACCP module of the *From Grapes to Glass* program, a code of good manufacturing practice is being drafted in collaboration with the Institute's Health and Regulatory Information Manager, and is ready for release in September 1999. This document will provide a reference support program for the implementation of food safety and quality systems and it is planned that this will gain official status and endorsement by the Industry.

Mark Gishen is assisting several other organisations in the staging of events of interest to the wine industry including a workshop on quality management for the 5th International Symposium on Cool Climate Viticulture & Oenology (Melbourne, January 2000), and part of the speaker program for the 6th Australian HACCP Conference (Adelaide, August 1999).

On a cost-recovery basis, Mark Gishen takes primary responsibility for the internal quality management systems of the Analytical Service, overseeing management reviews, documentation, auditing, and corrective actions. Reviews conducted throughout the year resulted in improvements in many areas including audit scheduling, and quality control checks in laboratory methods. 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 Analytical Service has purchased and begun implementation of a quality management software package called *Paradigm Quality*. This was purchased primarily to assist in the task of document control, but will also assist in the control of all other aspects of the quality system. Policy documents and laboratory methods are being installed on the system continuously and it appears that considerable efficiencies will be realised in electronically maintaining our large body of documentation.

Following a successful feasibility study, a 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 was commenced. The details of this project are reported under the GWRDC-funded project, AWR 98/2 *Analysis of quality parameters in grapes and wine using Near Infrared Spectroscopy (NIRS)* elsewhere in this Annual Report.

Provision of technical information

Staff: Peter Godden, Catherine Daniel, Ingrid Oats and Rae Blair

The John Fornachon Memorial Library

The John Fornachon Memorial Library holds the largest collection of technical wine literature in Australia. The Library's principal responsibility is to provide technical information to the Australian wine industry and to the researchers of the Institute. The Library is also used extensively by other groups such as students, government bodies and private companies.

Information and document delivery services

The John Fornachon Memorial Library has excellent access to international databases, particularly in the fields of science, technology and medicine. If requested, the Librarian, Catherine Daniel, will carry out online searches on commercial databases on any appropriate topic. The cost of an online search depends on the complexity of the subject and may range from $50

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From left: Catherine Daniel, Creina Stockley and Ingrid Oats

onwards. Only costs directly incurred in carrying out an online search are passed on to the wine industry client. Alternatively, library staff can provide, free of charge, a report of relevant articles indexed on the Library's in-house databases. It is anticipated that wine industry clients will be able, in the near future, to obtain external access to the Library's in-house databases (24 hours a day) through a searchable web-based product being developed - see report below. A trial with a commercially available software package has shown great potential.

Examples of free library services include answering information queries, providing reports of searches conducted on the Library's in-house databases, and supplying copies of Institute staff papers and Technical Notes. A summary of information requests for 1998/99 is presented in Table 3.

Document delivery

The Library can supply either books or photocopies 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.

Specialized information services

The library staff continue to be actively involved in the production of specialized 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 bimonthly *Technical Review*, the *Technical Review Index*, and several in-house technical information databases.

Library collection

Eighty-seven monographs and seventeen conference proceedings were added to the Library collection during 1998/99. The Library subscribes to 58 journals and receives approximately 70 annual reports, journals and newsletters through exchange and donation. The Library also maintains a collection of over 18000 reprints.

Library databases

Apart from a computer-based catalogue of books and journal holdings, the Library has several specialist in-house databases, which index over 28,000 scientific and technical reprint articles; over 2,000 articles on the medical aspects of alcohol consumption; the registrations and maximum residue limits of vineyard agrochemicals used in Australia's main export markets; brief records detailing the wine regulations for permitted preservatives and processing aids in nearly 60 countries; and the bibliographic details of the Library's collection of the European Union wine legislation.

Catherine Daniel 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 4.

Online access project

In March 1999, the Institute submitted to the GWRDC an application to enable the development of a web-based searchable product, that would allow Australian wine levy payers the ability to search through the Institute's databases 24 hours a day from a remote location. This application was approved, and the Library staff have been undertaking, and will continue to undertake the enormous task of preparing the library's existing database records for importation into the new structure. Additionally, the Librarian and the Communication and Publicity Manager are also undertaking negotiations with trade and journal publishers to resolve the many issues associated with providing access to published material by wine industry personnel for research and personal study.

Technical Review

Technical Review is received by all Wine levy paying wineries in Australia and, through subscription, by government and other organizations and individuals, both in Australia and overseas. *Technical Review* provides progress reports to the Industry on the Institute'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 or from the *Technical Review Index*. Demand for such articles continues to be high. Technical Review is edited by Creina Stockley, the Health and Regulatory Information Manager and is partially supported by The Thomas Walter Hardy Trust Fund.

Table 3. Summary of information requests during 1998/99

	Wine Industry	Staff	Other	Total
Information requests	139	48	151	338
Online database searches	10	75	~	85
Interlibrary loans				
requests sent[1]	9	552	~	561
requests received[2]	~	~	122	122
Technical Review requests[3]	~	~	~	185
Technical Review articles forwarded[4]	~	~	~	1062
Article requests[5]	~	~	~	53
Articles forwarded[6]	~	~	~	224
Number of Institute publications forwarded	~	~	~	357

[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] Requests received for articles within the JFML library or database.
[6] Number of articles forwarded, excluding staff publications (usually more than one article is requested).

Table 4. Number of records on the Library's catalogue and information databases

Library catalogue databases	Number of records
BOOKFILE: books, conferences and theses	3116
ARTICLES: scientific papers	28727
MEDIC: medical papers	2005
JOURNALS: journals, newsletters, statistics and annual reports	384
Library information databases	
PRESERVE: wine additives legislation	783
REGS: European Community wine legislation	338
AGROCHEM: agrochemicals	1917
MAILNEW: contact names and addresses	1912
ISYS-full-text retrieval database covering United States of America Federal Register	629

Email service

A leaflet was inserted into the December 1998 issue of the *Technical Review*, offering an *Email advice and information on technical issues* service. This service is a fast and cost-efficient way of disseminating important technical information quickly to interested members of the Australian Wine Industry. We were pleased with the response received for this service, as over 130 subscribers have supplied their email addresses to date. Two electronic bulletins have been issued since the formation of the service. Industry staff wishing to receive this service should email our Communication and Publicity Manager, Rae Blair (on rblair@awri.adelaide.edu.au).

The John Fornachon Memorial Library Endowment Fund

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

Acknowledgments

The Institute wishes to thank all individuals and companies who contribute to the collection through donations or exchange agreements. The support of the following persons and organizations that have donated books or journals 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 Organization, K.F. Pocock, D.J. McWilliam, Dr B.C. Rankine, Dr J. Spawner, Dr J. Spooner, The University of Adelaide, Viticultural Publishing Inc., Winemakers' Federation of Australia Incorporated.

Industry Services Teams' reports

To develop links between viticultural and oenological research

Staff: Alex Sas

The Viticulturist has continually performed tasks and activities which link viticultural knowledge and research with Oenologist counterparts. This is particularly true through the interaction with CSIRO Plant Industry in regard to agrochemical use in Australian viticulture, and also through his considerable involvement in technology diffusion. Specific activities are outlined below.

Increase in enquiries received

> *During 1998/99, a total of 656 enquiries were received by the Viticulturist, an increase of 11% on the previous 12 months. The majority of enquiries were regarding the use of agrochemicals for pest and disease control; the persistence of residues through winemaking and their effects on fermentation; and issues related to maximum residue limits in overseas markets.*

Successful project applications

Many of these enquiries were from grapegrowers and winemakers concerned about late-season *Botrytis* bunch rot, which was wide-spread. The severity of this outbreak in some regions reinforced an earlier decision to request funding from the CRC for Viticulture to develop a rapid test to measure the amount of *Botrytis cinerea* and associated rots in grapes. This project recently received funding from the CRC for Viticulture II and will be conducted in collaboration with Amanda Hill of CSIRO Plant Industry, Canberra.

Industry awareness of chemical residue issues

A highlight this year was the launch of the 'agrochemicals information' website in August. The site was designed, and is maintained by the Viticulturist with support from the Librarian, and lists: the preferred chemicals for use in winegrape production; all products registered for use in viticulture; resistance management strategies; and maximum residue limits (MRLs). It also has a 'news and notices' page. The website (www.waite.adelaide.edu.au/AWRI/agrochem/agrochem.htm) complements the Institute's annual publication, *Agrochemicals registered for use in Australian viticulture*, however, has the added benefits of being updated more regularly and the inclusion of the MRL database. Upon request, information found on the website is faxed to those without access to the internet.

The circulation of the agrochemicals booklet to grapegrowers was dramatically increased this year by its inclusion as a supplement in the September edition of the *Australian Grapegrower and Winemaker.* As in past years, the booklet was posted free to every Australian winery, and was prepared with the assistance of Catherine Daniel, the Institute's Librarian. Parts of the booklet and website were reprinted in several industry magazines and manuals.
This information assists wineries and grapegrowers with the selection of pest and disease control strategies that minimise the risk of unwanted chemical residues in wine.

From left: Greg Ruediger and Alex Sas

Development of rapid tests to measure chemical residues

Alex Sas is also a collaborator on the GWRDC-funded project, *Simple screening methods for chemical residues in Australian wine and wine grapes,* which is reported in detail in the GWRDC Annual Report, submitted by CSIRO Plant Industry. The project, which is conducted in collaboration with CSIRO Plant Industry, is in its last phase and some of the tests are nearly ready for commercial release. Our commercial partner, EnviroLogix, produced prototype kits that measure organophosphate/carbamate, organochlorine and carbendazim residues, which were used in the training of staff from 30 wineries by the Viticulturist and Dr John Skerritt. Eighteen wineries then evaluated the kits in-house over a four-month period. The conclusion from this trial was that the assays were reliable, relatively easy to use and enabled a high throughput of samples.

Provision of technical information and industry training

The following activities were conducted by the Institute's Viticulturist:

- facilitation of six IPM Viticulture: *Research to Practice* workshops in SA and WA;
- preparation of abstract and relevant articles for the Institute's bi-monthly publication, *Technical Review*;
- participation in the Institute's 'Roadshow' visits to Western Australia (see Appendix 1); and
- coordination of poster display at Tenth Australian Wine Industry Technical Conference and co-editing the proceedings.

* Information on other activities of the Viticulturist can be found in Appendix 1.

Preparation of information on wine and health issues

Staff : Creina Stockley

This project has been funded since 1990. Creina Stockley, a clinical pharmacologist, assumed this position in 1991 as part of her responsibilities as Health and Regulatory Information Manager. A database of research on the beneficial and detrimental health effects of alcohol and in particular, wine, was established as part of the John Fornachon Memorial Library database. This was 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. During 1998/99, 65 independent information requests received on wine and health issues from industry, government and the general public were fielded by the Health and Regulatory Information Manager.

Subscription to relevant medical and other journals has continued. 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 Institute's 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. On a cost-recovery basis, six lectures have been prepared and presented on wine and health issues for the Graduate Diploma in Wine Science inaugural subject, Wine in Society, of The Department of Horticulture, Viticulture and Oenology of The University of Adelaide (see Appendix 2).

Submissions prepared on behalf of the Australian wine industry include, but are not limited to:

- the Draft National Strategic Frame work 1998-2002: A Community Partnership on Drugs Strategy of the Federal Department of Health and Family Services;
- both the Draft National Strategic Plan on Alcohol Strategy of the Federal Department of Health and Family Services, and the Draft National Drug Strategy Alcohol Action Plan 1999 Strategy of the Federal Department of Health and Family Services documents;
- the Draft National Youth Alcohol Strategy of the Federal Department of Health and Family Services;
- Review of the recommendations regarding responsible drinking of the National Health and Medical Research Council of Australia;
- Application 359–Labelling of alcoholic beverages 'This product contains alcohol. Alcohol is a dangerous drug', of the Australia New Zealand Food Authority; and
- Draft resolution 98/121 Educational program 'wine, alcohol and society: healthy lifestyles and behaviour'–Part 2 (version 2 modified) of the Nutrition and Wine Expert Group of the Office International de la Vigne et du Vin (OIV).

Project coordination:

- AWF-funded – *Gender differences in the metabolic response of young people to alcohol*, in conjunction with Charles Sturt University, Department of Gastroenterology of St Vincent's Hospital, Melbourne, School of Veterinary Medicine of the University of Pennsylvania.
- GWRDC-funded AWR97/2 – *Potential cardio- and cancer-protective effects and mechanisms of wine.*

The Health and Regulatory Information Manager is a participant in, and co-ordinator of, three GWRDC-funded subprojects under this umbrella, namely:

- HRI97/2 Potential cardioprotective activities of wine components based on synergistic interaction with vitamin E. Principal Organisation: Heart Research Developments Pty Ltd.

Staff: Dr Roland Stocker, CoVien Phu

Briefly, male apolipoprotein E gene knockout mice (8 to 10 weeks old) were maintained on a high fat diet containing 21.2% (w/w) fat and 0.15% (w/w) cholesterol; these mice are an animal model commonly used for atherolsclerosis, as the mice when fed on a high fat or western diet, develop atherosclerotic lesions similar to those observed in humans. The animals were supplemented by gastric gavage with water (control), whole wine (red, white and de-alcoholized

red wine) or its equivalent Fraction 1 (equivalent to 200 mL wine per 70 kg per day) daily for one month. Blood was then obtained through intra-cardiac puncture and the heparinized plasma prepared for analysis of -tocopherol, ascorbate, total cholesterol, total triglyceride, low density lipoprotein and high density lipoprotein.

Our preliminary results indicate a cholesterol-lowering activity of de-alcoholized red wine and white wine Fraction I, or a component thereof. Thus, the administration of de-alcoholized red wine or white wine Fraction I at a dose equivalent to the daily consumption of 200 mL wine by a 70 kg person per day, to apolipoprotein E gene knockout mice for one month significantly decreased the plasma concentration of cholesterol from 5.2 ± 5.1 mM (control) to 1.0 ± 0.3 mM (de-alcoholised red wine; $p = 0.0012$) and 1.3 ± 0.1 mM (white wine Fraction I; $p = 0.0012$). Both de-alcoholised red wine and white wine Fraction I did not affect plasma concentration of triglycerides, although the plasma concentration of -tocopherol was also decreased to an extent similar to that of cholesterol with strong correlation.

The cholesterol-lowering effects observed were dramatic. If confirmed with larger animal numbers, they could indicate a potential protective activity of de-alcoholised red wine and white wine Fraction I against cardiovascular events, particularly if the decrease in the plasma concentration of cholesterol was associated with the decrease in the concentration of buoyant (that is, pro-atherogenic) lipoprotein cholesterol. In addition to the observed cholesterol and -tocopherol - or vitamin E-lowering effects, de alcoholised red wine also seemed to decrease plasma lipid oxidizability and the plasma concentration of very low density lipoprotein (VLDL), a constitutent of LDL.

- UWA97/2 Grape antioxidant phenolics: absorption and inhibition of lipid peroxidation in humans. Principal organisation: Department of Medicine, The University of Western Australia.

Staff: Dr Kevin Croft, Associate Professor Ian Puddey, Professor Laurie Beilin, Rima Abu-Amsha Caccetta

A number of groups have shown that phenolic compounds in red wine exert antioxidant effects on *in vitro* lipoprotein oxidation leading to speculation that red wine consumption mediates unique anti-atherosclerotic effects compared to other alcoholic beverages. The results of a study on the effects of short-term red wine consumption to 12 male volunteers by measurement of lipoprotein oxidation *ex vivo*, however, were not conclusive. Therefore, a longer-term, cross-over intervention study was conducted to measure F_2-isoprostanes, which are currently the best available biomarker of *in vivo* lipid peroxidative damage.

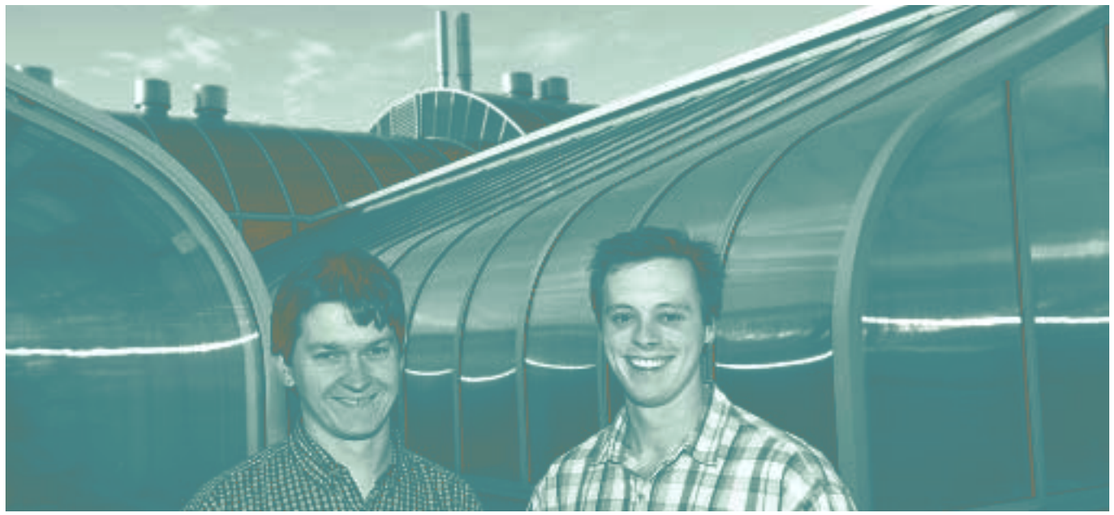
Eighteen male smokers (greater than 10 cigarettes per day) were studied because of evidence that smoking increases the level of oxidative stress. They consumed red wine, de-alcoholised red wine or white wine for two consecutive weeks with a one-week wash-out period between beverages. Before and after each beverage, the concentration of both plasma and urinary F_2-isoprostanes was measured. Serum -GT was monitored as an indicator of alcohol consumption and urinary 4-O-methylgallic acid, a major metabolite of gallic acid, was measured as an indicator of the absorption of phenolic acids. The plasma concentration of F_2-isoprostanes ($p<0.05$) decreased significantly with de-alcoholised red wine as compared with the alcohol-containing beverages. The urinary concentration of F_2-isoprostanes decreased significantly with de-alcoholised red wine when compared with red wine ($p<0.05$). The concentration of -GT decreased significantly with de-alcoholised red wine and increased with both alcohol-containing beverages ($p<0.0005$). The urinary excretion of 4-O-methylgallate increased in the 24-hour urine samples following red wine or de-alcoholised red wine ingestion, but not with white wine.

The results from this study suggest an antioxidant effect of de-alcoholised red wine to inhibit lipid peroxidation *in vivo*. In the alcoholic beverages, the antioxidant effects of the phenolic compounds may have been counteracted by the pro-oxidant effects of the ethanol component.

- CSN97/2 Reduction of damage to LDL and DNA from oxidative free radicals by the regular and moderate consumption of wine. Principal organisation: CSIRO Division of Human Nutrition.

Staff: Will Greenrod

Will Greenrod, the appointed PhD candidate, commenced work on this project in June 1998. Approval was obtained from both the CSIRO Division of Human Nutrition Ethics Committee and that of The University of Adelaide, for the first clinical intervention examining the immediate effects of wine consumption on *in vivo* changes in blood that may be protective against oxidative damage to DNA. In the interim, experimental protocols were optimised for the detection of DNA damage using the cytokinesis blocked micronucleus (MN) assay. The use of nucleoplasmic bridges as an additional measure of chromosome rearrangement was evaluated and shown to be a valuable complementary sensitive end-point to the MN assay; nucleoplasmic bridge measurements have now been included in the project. Dose-response curves for human lymphocytes to oxidative damage induced by hydrogen peroxide and ionising radiation were established, and the test doses for the subsequent experiments were selected accordingly; an excessive dose of either agent leads to excessive cell death where the mutation rates can not be accurately assessed. *In vitro* experiments examining the protective effects of alcohol, glycerol, tartaric acid, catechin, mixture of these components and stripped white wine against induced oxidative damage to lymphocytes have been completed. Human lymphocyte cells were collected from human volunteers after the consumption of 300 mL of red wine and a model-wine solution (control); these cells were then subjected to the pre-established doses of hydrogen peroxide and ionising radiation. The slide scoring to access the mutation rate and hence DNA damage of these cells is currently being conducted to determine whether any of the specific components of wine protected them from the induced oxidative damage.



From left: John Hughes and Matt Holdstock

The first clinical intervention examining the immediate effect in blood following the consumption of wine has been completed. In this intervention, eight human volunteers were required to maintain a diet low in phenolic compounds for two days prior to the study in order to maximise the detection of effects from wine-derived phenolic compounds. During the study, the volunteers consumed either whole red wine, de-alcoholised red wine or an alcohol solution, and blood samples were collected during the first four hours post-consumption. A proportion of the blood samples were challenged with a single acute dose of ionising radiation while the rest of the samples was fractionated to collect blood plasma. Plasma has been stored frozen for subsequent challenges to test the resistance to hydrogen peroxide damage to DNA. The latter challenges will commence in July 1999.

The scoring of slides for assessment of DNA damage is time consuming compared to routine biochemical techniques and is expected to overlap with other phases of this project. Furthermore, additional analysis of slides from the hydrogen peroxide challenges may be required to take account of necrosis events, which we have been recently shown to be a potential confounder in the DNA damage assay.

The commencement of the first clinical intervention was delayed by two months because of difficulties with securing a reliable source of de-alcoholised red wine to match the whole red wine selected for the intervention. Consequently, it was necessary for Mr Greenrod to spend additional time developing a vacuum distillation procedure to produce the required de-alcoholised wine. Analyses by the Institute showed that the de-alcoholised wine produced by Mr Greenrod was free of alcohol and proved to be palatable to volunteers in the intervention.

All three subprojects commenced their second year of funding.

Project participation:

- GWRDC-funded *Wine and health: does it effect consumer attitudes and consumption of wine,* in conjunction with the Department of Horticulture, Viticulture and Oenology of The University of Adelaide and The Australian Centre of Wine Business Management of the School of Marketing of The University of South Australia

Technical and regulatory support to the Australian wine industry

Staff: Peter Høj, Creina Stockley and Rae Blair

One of the activities of the Institute has been to provide legal/regulatory and technical advice and assistance to the Australian Wine Industry, through the Health and Regulatory Information Manager and the Industry Services Team. During 1998/99, 108 independent information requests on technical and regulatory issues from the government and industry were fielded by the Health and Regulatory Information Manager.

At present, Peter Høj is a member of the Prime Minister's Science, Engineering and Innovation Council and serves on the following Committees and Boards: International Trade and Technical Advisory Committee and Wine Practices Committee of the Australian Wine and Brandy Corporation; the Technical Committee of the Winemakers' Federation of Australia; and the Wine Committee of the Royal Agricultural and Horticultural Society of South Australia. He serves on the editorial board of the *Journal International des Sciences de la Vigne et du Vin*; Committee of Management, Viticultural Publishing, publisher of *Australian Journal of Grape and Wine Research*. He is also the Chair of the Conference Planning Committee of the Eleventh Australian

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Wine Industry Technical Conference (7-10 October 2001, Adelaide) - he served the same role for the Tenth Conference (2-5 August 1998, Sydney). He is co-editor of the Proceedings of the Tenth Conference, and is a member of the Australian Organising Committee of the 26th World Congress and 81st General Assembly of the Office International de la Vigne et du Vin (OIV) (11-18 October 2001, Adelaide).

Creina Stockley is a member of the Australian Wine and Brandy Corporation's International Trade and Technical Advisory Committee and the Legislative Review Committee and a member of the Technical Committee of the Winemakers' Federation of Australia. Rae Blair is a member of the Conference Planning Committee and is the Treasurer and Conference Manager of the Eleventh Australian Wine Industry Technical Conference (she served the same role for the Tenth Conference - 2-5 August 1998, Sydney). She is co-editor of the Proceedings of the Tenth Conference and is also a member of the Australian Organising Committee of the 26th World Congress and 81st General Assembly of the OIV.

During 1998/99, significant efforts, energies and resources have been directed towards the Review of Alcoholic beverages in the Australian Food Standards Code, in particular the redrafting of Standard P4 for wine, sparkling wine and fortified and Standard P6 for wine products; 18 different position and other papers have been prepared, and approximately 12 versions of a draft standard. The current statutory Australian and New Zealand standards for winemaking are to be harmonised, which reflects the requirements of the *Australia New Zealand Closer Economic Relations Trade Agreement* of 1983 and the subsequent *Agreement between the Government of Australia and the Government of New Zealand establishing a System for the Development of Joint Food Standards* of 5 December 1995. This harmonisation is superimposed on a simplification of the standard suggested by ANZFA.

During 1998/99, technical information and/or issues that have been reviewed, and discussion or position papers prepared, by the Health and Regulatory Information are not limited to, but include the following:

- Wine product recall procedures; and
- *Code of good winemaking practice,* in conjunction with the Institute's Quality Liaison Manager.

From left: Randall Taylor, Jeremy Hack and Matthew Cream

In addition, technical and regulatory information was also prepared for presentation at the 1999 European Union and Australia Joint Committee Meeting of the *Agreement between the EU and Australia for Trade in Wine (1994)* held in Perth, WA during July 1999; and the General Assembly and Expert Group meetings of the OIV in March 1999.

Technical information is also disseminated to the Australian wine industry, including all wine levy payers, by the Institute's bimonthly publication, *Technical Review*, of which the Health and Regulatory Information Manager is editor (via GWRDC project AWR 12 *Provision of technical information*).

This project of technical and regulatory support to the Australian wine industry is ongoing, as technical and regulatory issues are regularly raised by the government or by industry, both in Australia and internationally. Furthermore, these issues often span several years.

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Analytical Service

Staff: Sue Weeks, John Hughes, Matthew Holdstock, Greg Ruediger, Gayle Baldock, Amanda Cook, Matthew Cream, Adam Fisher, Peter Graves, Jeremy Hack, Radka Kalouch, Andrea Kemp, Adam Loveys, Kevin Pardon and Randall Taylor

The Analytical Service, first established in 1984, is a commercial facility run independently of GWRDC-funded activities. The Analytical Service serves as a conduit for provision to the Australian Wine Industry of practical outcomes of the Institute's published research. The Analytical Service conducts up to 40,000 individual analyses on wine per annum and offers a wide range of different measurements, many of which are adapted from our own research. Recent examples of this are the oak flavour analysis and the TCA analysis which were both launched to Industry in August 1998. The availability of both the oak and the TCA analyses affords to the Industry an independent and objective means to evaluate crucial performance parameters of two of the most prominent products supplied to the wine industry: oak products and natural cork closures. We are pleased to say that industry increasingly use these sophisticated measures to further understand and improve their products. Along with the agrochemical residue analyses, these analyses are prime examples of the Institute's ability and commitment to secure the transfer of research to practice.

Also this year, several Analytical Service staff finalised the validation and method protocol for the new yeast assimilable nitrogen analysis. This two-step analysis involves the measurement of both ammonia and alpha amino nitrogen and was provided as a new service in time for the 1999 Vintage.

A further new service became available this year when staff of the Analytical Service validated the method for analysis of ethyl carbamate, in conjunction with the Institute's Mass Spectrometry Manager, Yoji Hayasaka.

In 1996, the Analytical Service was the first commercial laboratory in the world to provide DNA typing for the identification of grapevine cultivars and rootstocks and use. The DNA test, initially developed by CSIRO, involves the extraction and analysis of DNA from the submitted plant material, to produce a DNA profile. This profile is compared with those in an established database of grapevine DNA profiles. The DNA profile is a unique 'fingerprint' that differentiates grapevine cultivars and rootstocks - it does not, however, differentiate between clones of a cultivar. Analysis methods were streamlined during the reporting period and demand for this service increased by 277% over the previous year.

Our Trace Analysis Laboratory (formerly known as the Residue Laboratory) was also kept particularly busy this year with a 114% increase in analyses undertaken over the 1997/98 year. The routine residue scan includes 28 residues, which include over 50 brand name agrochemicals. The analysis is accredited by NATA and is regularly exposed to international proficiency testing. The Trace Analyses Laboratory has also witnessed an increasing demand for oak and TCA analyses, and demand for these analyses is expected to increase dramatically as winemakers realise the potential to better control and understand outcomes of their winemaking practices through state of the art analyses.

The Analytical Service has maintained its National Association of Testing Authorities (NATA) registration since 17 March 1986 in the fields of chemical testing for food, specifically alcoholic beverages and metrology for our equipment calibration services. The laboratory is also recognised as an approved wine analysis laboratory by EU, Japanese and several other overseas governmental authorities.

During the year, the Service took delivery of a new Atomic Absorption Spectrophotometer. The Perkin Elmer 'AAnalyst 300' offers many features previously unavailable to the Service including automation and upgrade options to allow greater analytical flexibility in the future.

In an endeavour to forge closer links with its customers, the Analytical Service took exhibition space at the Tenth Australian Wine Industry Technical Conference Trade Exhibition, held in Sydney, August 1998. Our participation was very beneficial to our customers as we were able to speak with over 250 visitors and distributed information kits on the Service. Additionally, Matt Holdstock, in conjunction with Sue Weeks, presented a poster at the Conference on the relationship between the measurements of volatile acidity and

Abridged Accounts of the Financial Report

for Year Ended 30th June 1999

From left: Sita Soetratma and Janet Currie

Statement by the Directors

In the opinion of the Directors, the abridged accounts of The Australian Wine Research Institute for the year ended 30 June 1999, as set out on pages 44 to 47, are drawn up so as to give a true and fair view of the company's financial position as at 30 June 1999, and its performance for the year then ended, having been extracted from the audited financial reports which are enclosed herewith at the back of the Annual Report or are available upon request.

Signed in accordance with a resolution of the Board of Directors this 26th day of October 1999.

Douglas James McWilliam
Chairman

Peter Høj
Director

The Australian Wine Research Institute

Abridged Profit And Loss Account for Year Ended 30th June 1999

	1999 $	1998 $
Income		
Grants received	3 511 128	3 142 986
Interest	60 752	31 785
Other Income	1 018 765	857 220
Total Income	4 590 645	4 031 961
Expenditure		
Staff	2 486 439	2 396 860
Travel	95 339	92 955
Amortisation and depreciation	275 466	252 672
Operating and other expenditure	1 264 825	1 070 543
Total Expenditure	4 122 069	3 813 030
Operating Profit for the Year	468 576	218 931

Balance Sheet as at 30th June 1999

	1999 $	1998 $
Current Assets		
Cash on hand and at bank	228 072	402 778
Trade and other receivables	291 991	211 882
Short term deposits	621 000	580 000
Other	0	2 640
Total Current Assets	1 141 063	1 197 300
Non-Current Assets		
Leasehold buildings	1 459 249	1 061 807
Plant and equipment	1 395 224	1 308 917
The Australian Wine Industry Chair of Oenology	840 000	840 000
Total Non-Current Assets	3 694 473	3 210 724
Total Assets	4 835 536	4 408 024
Current Liabilities		
Accounts payable	378 714	376 096
Provision for employee entitlements	274 273	210 019
Total Current Liabilities	652 987	586 115
Non-Current Liabilities		
Provision for employee entitlements	107 470	215 406
Total Non-current Liabilities	107 470	215 406
Total Liabilities	760 457	801 521
Net Assets	4 075 079	3 606 503
Accumulated Funds		
Retained profit at the beginning of the year	2 036 686	1 817 755
Plus operating profit for the year	468 576	218 931
Retained profits at the end of the year	2 505 262	2 036 686
Asset revaluation reserve	603 067	603 067
Capital reserve	966 750	966 750
Total Accumulated Funds	4 075 079	3 606 503

Abridged Accounts of the Financial Report

for Year Ended 30th June 1999

Statement of Cash Flows for Year Ended 30th June 1999

	1999 $	1998 $
Cash Flows From Operating Activities		
Grants and other income	4 433 588	3 982 286
Interest received	60 752	31 785
Payments to suppliers and employees	(3 885 027)	(3 301 225)
Net cash provided by operating activities	609 313	712 846
Cash Flows from Investing Activities		
Redemption of (payment for) investments	(41 000)	(121 415)
Payments for building improvements	(422 681)	0
Payments for plant and equipment	(390 088)	(380 468)
Proceeds from sale of plant and equipment	69 750	47 750
Net cash used in investing activities	(784 019)	(454 133)
Net increase (decrease) in cash held	(174 706)	258 713
Cash at 1 July 1998	402 778	144 065
Cash at 30 June 1999	228 072	402 778
Reconciliation of Net Cash Provided by Operating Activities with Operating Profit		
Operating Profit	468 576	218 931
Non-cash flows in operating profit:		
Amortisation and depreciation	275 466	252 672
Profit on the sale of plant and equipment	(16 196)	(5 590)
Charges to (reduction in) provisions	(43 682)	34 475
Changes in assets and liabilities:		
(Increase)/Decrease in receivables and prepayments	(77 469)	(2 534)
Increase/(Decrease) in sundry creditors and accruals	2 618	214 892
Net cash provided by operating activities	609,313	712,846

The Australian Wine Research Institute Memorial Trust Funds

The Australian Wine Research Institute holds monies in trust for four funds:

The John Fornachon Memorial Endowment Fund

This fund was established in September 1970 to provide for the establishment and maintenance of the Fornachon Memorial Library, as a memorial to the late John Fornachon.

The fund contributed an amount of $6 500 to the publication of the *Technical Review*. The fund had total trust funds of $83 152 as at 30 June 1999.

The H. R. Haselgrove Memorial Trust Fund

This fund was established in December 1979 to provide for the promotion and encouragement of wine research, as a memorial to the late Harry Haselgrove.

The fund had total trust funds of $45 770 as at 30 June 1999.

The Thomas Walter Hardy Memorial Trust Fund

This fund was established in June 1993 to assist in the communication of information within the wine industry, in memory of the late Thomas Hardy.

During the year ended 30 June 1999 the founder donated a further $5 000 to the Fund. The Fund contributed an amount of $3 150 to the publication of the *Technical Review*.

The fund had total trust funds of $56 386 as at 30 June 1999.

The Stephen Hickinbotham Memorial Research Trust

This fund was established in October 1986 to provide financial assistance and support in the pursuit of scientific research and associated activities allied to the wine industry, in memory of the late Stephen Hickinbotham.

The fund had total trust funds of $80 426 as at 30 June 1999.

Independent Auditors Report to the Members of The Australian Wine Research Institute

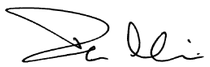
We have audited the Abridged Financial Report of The Australian Wine Research Institute for the year ended 30 June 1999 as set out on pages 44 to 47, in accordance with Australian auditing standards.

The Abridged Financial Statements are derived from the annual financial statements of The Australian Wine Research Institute and the Trust Funds for which it acts as Trustee. In our Auditor's Reports to the Members on the annual financial reports, dated 26th of October 1999, we expressed unqualified audit opinions.

In our opinion, the information reported in the Abridged Financial Statements is consistent with the annual financial reports from which they have been derived, and upon which we expressed unqualified audit opinions.

For a better understanding of the scope of our audits, this report should be read in conjunction with our Auditor's Reports on the annual financial reports.

Pannel Kerr Forster
A South Australian Partnership
Chartered Accountants



DA Major
Partner

Signed at Adelaide this 26th day of October 1999.

The Australian Wine Research Institute

Appendices

Appendix 1
External seminars, talks and poster papers presented by Institute staff during 1998/99

Author	Title	Organization/Location	Date
External seminars and talks			
M.A. de Barros Lopes	Genetic improvement of wine yeasts.	Faculty of Science and Agriculture, Charles Sturt University, Wagga Wagga, New South Wales.	13 July, 1998
P.B. Høj	Research and Development in the Australian Wine Industry.	South Australian State Parliament, Adelaide, South Australia.	22 July, 1998
P.B. Høj, P.F. Hayes[1]	The Australian wine industry's research and development effort and its importance for sustained growth.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2 August, 1998
C.S. Stockley	Facts about wine and health.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2 August, 1998
A. Soden[2,3,7], I.L. Francis, H. Gockowiak, T.H. Lee[2,3] and P.A. Henschke	The use of non-*Saccharomyces* yeast in winemaking.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	3 August, 1998
E.J. Bartowsky	Random microbial oxidative spoilage of bottled red wine.	Poster break-out presentation at the Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	4 August, 1998
N.G.C. Bruer	Microbiological spoilage of Pinot Noir wines after bottling.	Poster break-out presentation at the Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	4 August, 1998
P.J. Costello	Mousy off-flavour spoilage of wine by lactic acid bacteria.	Poster break-out presentation at the Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	4 August, 1998
I.L. Francis	Grape quality and the G-G assay.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	4 August, 1998
P.W. Godden	Measuring desirable oakwood components in wine.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	4 August, 1998
P.R. Grbin[3,4], A.J. Markides[5], T.H. Lee[2,3], P.A. Henschke	Dependence of nitrogen source for the formation of mousy wine off-flavour N-heterocyclic compounds by *Dekkera* yeast.	Poster break-out presentation at the Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	4 August, 1998
A. Oberholster	Routine methods to determine the complete polyphenolic profile of red wines.	Poster break-out presentation at the Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	4 August, 1998
Z.K. Peng	Effect of grape seeds on the phenolic profile of Shiraz wine.	Poster break-out presentation at the Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	4 August, 1998
A.N. Sas	Meeting a salt specification.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	4 August, 1998
R. van Heeswijck[5], P.B. Høj	Overview of gene technology.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	4 August, 1998
J.M. Eglinton	Restarting stuck fermentations which contain high volatile acidity.	Poster break-out presentation at the Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	5 August, 1998
M. Gishen	Application of near infrared spectroscopy (NIRS) for assessment of grape quality.	Poster break-out presentation at the Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	5 August, 1998
M. Gishen, R. Dambergs[6]	Application of near infrared spectroscopy (NIRS) for quality assessment of wine and spirits.	Poster break-out presentation at the Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	5 August, 1998
H. Gockowiak	Effect of inoculation timing on malolactic fermentation.	Poster break-out presentation at the Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	5 August 1998
D. Liacopoulos, G.K. Skouroumounis, D.A. Barker[5], P.R. Howland[5], A.P. Pollnitz, K.H. Pardon, D.C. Alcorso[5], H.J. McLean[5], R. Gawel[5], M.A. Sefton	Chloroanisole taint in wines.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	5 August, 1998
K.F. Pocock	The effect of mechanical harvesting and fruit transport on juice and wine protein instability.	Poster break-out presentation at the Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	5 August, 1998
G.K. Skouroumounis	Quantification of important aroma compounds in grapes and wines.	Poster break-out presentation at the Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	5 August, 1998
C.S. Stockley	Wine and Health issues.	Somerton Park Probus Club, Somerton Park, South Australia.	8 August, 1998
M.A. de Barros Lopes	Molecular mapping in yeast - what can it tell us?	Department of Plant Science, The University of Adelaide, Waite Campus, Urrbrae, South Australia.	24 August, 1998
P.A. Henschke, M.A. de Barros Lopes, J.M. Eglinton, C. Smyl[3,8], A. Soden[2,3,7], C.M. Sutherland[3,8], N.A. Yap[3,8] and P.R. Langridge[9]	New generation wine yeast: biotechnology in oenology.	19th International Specialised Symposium on Yeasts. University of Minho, Braga, Portugal.	30 August to 3 September, 1998
C.M. Sutherland	Genetic manipulation of wine yeast to reduce hydrogen sulfide production.	Department of Horticulture, Viticulture and Oenology, The University of Adelaide, Waite Campus, Urrbrae, South Australia.	2 September, 1998
C.S. Stockley, P.B. Høj	Wine and health issues for China.	Delegation from People's Republic of China, Plant Research Centre, Waite Campus, Urrbrae, South Australia.	16 September, 1998
J.M. Eglinton	Reducing VA in wine: Is the *ALD7* gene the answer?	Department of Horticulture, Viticulture and Oenology, The University of Adelaide, Waite Campus, Urrbrae, South Australia.	16 September, 1998

Appendices

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External seminars, talks and poster papers presented by Institute staff during 1998/99

Author	Title	Organization/Location	Date
P.B. Høj	Chair of Session.	Annual Meeting of the Australian Society of Biochemistry and Molecular Biology, Adelaide, South Australia.	26 September to 1 October, 1998
C. Sutherland	Reducing hydrogen sulfide production by wine yeast.	Department of Horticulture, Viticulture and Oenology, The University of Adelaide, Waite Campus, Urrbrae, South Australia.	30 September, 1998
M. Gishen	Near infrared spectroscopy (NIRS) for assessment of grape quality.	Vititec '98, Penola: South Australia.	28 October, 1998
P.B. Høj	The importance of education and R&D for the successful development of the Australian wine industry.	Royal Australian Chemical Institute's annual general meeting. Chessar Cellars, Adelaide, South Australia.	3 November, 1998
C.S. Stockley	A role for the Australian wine industry in community harm reduction and prevention strategies.	Australian Professional Society for Alcohol and Other Drugs, Sydney, NSW.	10 November, 1998
P.B. Høj	The generation and maintenance of a 'learning and innovative culture', a necessary investment and a critical element for the wine industry's continued prosperity.	Rural Media Association's meeting at the Hickinbotham Roseworthy Wine Science Laboratory, Waite Campus, Urrbrae, South Australia.	12 November, 1998
P.B. Høj, P.W. Godden, P.A. Henschke, M.A. Sefton, A.N. Sas, N.G.C. Bruer	Roadshow 'seminars'.	Swan Valley, WA Albany, WA Margaret River, WA.	23 November 25 November 27 November, 1998
M. Gishen	Options in quality management for grapegrowers.	Presentation to NSW Wine Industry Association, Research and Development committee, Sydney, NSW.	11 January, 1999
P.A. Henschke	Approaches to yeast propagation and fermentation management: nutrition.	BRL Hardy Pre-Vintage Fermentation Meeting, Reynella, South Australia.	13 January, 1999
I.L. Francis	Grape quality assessment.	New Zealand grapegrowers and winemakers/HortResearch Blenheim, New Zealand Napier, New Zealand.	 15 February 17 February, 1999
P.W. Godden	Winemaking in Australia.	Japanese farmers, winegrowers and winemakers from the Kobe region, Plant Research Centre, Waite Campus, Urrbrae, South Australia.	3 March, 1999
P.B. Høj	Agriculture: Food and Wine (Chair of Session).	14th Australasian Biotechnology Conference, Glenelg, South Australia.	22 April, 1999
I.L. Francis	Grape berry quality measurements: recent developments.	Margaret River Field Day Seminar, Margaret River WA.	7 May, 1999
P.J. Costello	Formation of mousy off-flavour in wine by lactic acid bacteria.	Department of Horticulture, Viticulture and Oenology, The University of Adelaide, Waite Campus, Urrbrae, South Australia.	19 May, 1999
C. Sutherland	Strategies to reduce H_2S production by *Saccharomyces cerevisiae* in the Australian wine industry.	Carlsberg Research Laboratories, Copenhagen Valby, Denmark.	21 May, 1999
A.N. Sas	Managing and measuring *Botrytis* and testing for chemical residues.	South Australian Farmers' Federation, McLaren Vale Growers' Day, McLaren Vale, South Australia.	26 May, 1999
I.L. Francis	Tannins and the sensory properties of red wines.	International Workshop on Tannins in Livestock and Human Nutrition, Adelaide, South Australia.	1 June, 1999
P.A. Henschke	1) Nitrogen and oxygen requirements of yeast: management fermentation and yeast strain specificity. 2) Red wine fermentation: potential problems, causes and remedies.	BRL Hardy Post-Vintage Technical Conference, Launceston, Tasmania.	1 June, 1999
E.J. Bartowsky	The microbiology of wine production.	School of Pharmacy and Medical Science, The University of South Australia, Adelaide, South Australia.	2 June, 1999
A.N. Sas	Using agrochemicals, selling wine.	Board of the National Registration Authority for Agricultural and Veterinary Chemicals, Waite Campus, Urrbrae, South Australia.	10 June, 1999
P.J. Costello	Mousy off-flavour spoilage of wine by lactic acid bacteria.	VI International Oenology Symposium, Bordeaux, France.	10-12 June, 1999
P.A. Henschke	Yeast nutrition and fermentation management.	C.A. Henschke & Co., Keyneton, South Australia.	11 June, 1999
M. Gishen, M.J. Kwiatkowski, W.U. Cynkar, P.B. Høj, I.L. Francis; R. Dambergs[6], A. Kambouris[5]	Application of near infrared spectroscopy (NIRS) for quality assessment of grapes, wine and spirits.	9th International conference on near infrared spectroscopy. Towards the third millennium. NIR-99, Verona, Italy.	13–18 June, 1999
A.N. Sas	Meeting market specifications.	Government Service Delivery Caucus Committee, Waite Campus, Urrbrae, South Australia.	17 June, 1999
P.J. Costello	1) Mousy off-flavour spoilage of wine by lactic acid bacteria. 2) Small-scale evaluation of Lallemand direct inoculation bacteria strains for induction of malolactic fermentation.	Centro de Investigacion y Desarrollo Agrario (CIDA), Rioja region, Spain. Navarra Viticulture and Oenology Centre (EVENA), Northern Spain, Spain. Locanda Gancia, Santo Stefano Belbo (AT), Peidemonte, Italy.	14 June, 1999 15 June, 1999 17 June, 1999

The Australian Wine Research Institute

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Author	Title	Organization/Location	Date
Poster Papers			
R.A. Asenstorfer[5], Y. Hayasaka, P.G. Iland[5], G.P. Jones[5]	Isolation and purification of the wine pigment - vitisin A.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
R.A. Asenstorfer[5], I.L. Francis, G.P. Jones[5]	Wine colour measurements: determination of the extinction coefficients of Malvidin-3-O-glucose and Malvidin-3-O-(6-p-coumaryl)-glucose.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
E.J. Bartowsky, T. Burvill[5,10], A. Hart[5,11], P.A. Henschke	Role of strain, citric acid and stuck fermentation on diacetyl production during malolactic fermentation.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
E.J. Bartowsky, D. Xia[12], G.H. Fleet[12], P.A. Henschke	Random microbial oxidative spoilage of bottled red wine.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August 1998
G.N. Borlace[5], P.A. Henschke, G.P. Jones[5], A.J. Markides[5]	Synergistic and inhibitory interactions between wine yeast and lactic acid bacteria.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August 1998
N.G.C. Bruer, A.D. Coulter, P.J. Graves	Microbiological spoilage of Pinot Noir wines after bottling.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW	2-5 August 1998
P.J. Costello, E.J. Bartowsky, P.A. Henschke	Susceptibility of lactic acid bacteria to lysozyme under wine conditions.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
P.J. Costello, E.J. Bartowsky, P.A. Henschke	Mousy off-flavour spoilage of wine by lactic acid bacteria.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
A.D. Coulter, N.G.C. Bruer, P.J. Graves	Techniques for the evaluation of wine closure performance.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW	2-5 August 1998
W.U. Cynkar, M.J. Kwiatkowski, H.G. Armstrong[8,13] , P.G. Iland[5], P.J. Williams, I.L. Francis	A National Vineyard Fruit Composition Survey.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW	2-5 August, 1998
M.A. de Barros Lopes, S. Rainieri[14], A. Soden, A. Martens[5], P.R. Langridge[9], P.A. Henschke	Molecular methods for the differentiation and identification of wine yeasts.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
M.A. de Barros Lopes, A.U. Rehman[9], H. Gockowiak, P.R. Langridge[9], P.A. Henschke	Altering glycerol metabolism of wine yeast for the production of lower alcohol wines.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
J.M. Eglinton, M.A. de Barros Lopes, P.R. Langridge[9], P.A. Henschke	Lowering fermentation efficiency of wine yeasts.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
J.M. Eglinton, P.A. Henschke	Isolation and identification of a cryotolerant yeast which has winemaking potential.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
J.M. Eglinton, P.A. Henschke	Restarting stuck fermentations which contain high volatile acidity.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998

The Australian Wine Research Institute

Author	Title	Organization/Location	Date
J.M. Eglinton, M.A. de Barros Lopes, P.R. Langridge[9], P.A. Henschke	The *ALD7* gene of *Saccharomyces* codes for an aldehyde dehydrogenase.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
R. Gawel[5], A. Oberholster, I.L. Francis	Characterising the astringent and mouthfeel properties of red wine.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
M. Gishen	Application of near infrared spectroscopy (NIRS) for assessment of grape quality.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW	2-5 August, 1998
M. Gishen, R. Dambergs[6]	Application of near infrared spectroscopy (NIRS) for quality assessment of wine and spirits.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
M. Gishen, L. Bowes[19]	Implementing quality management systems with less pain—*From Grapes to Glass.*	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
M. Gishen, D. Allen[15]	On-site generation of nitrogen gas for sparging and blanketing of wines.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
M. Gishen, M.G. Holdstock, M.J. Kwiatkowski, I.L. Francis	Analysis of malic acid in red wines by enzymatic kits – removal of interferences to avoid overestimation.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
H. Gockowiak, P.A. Henschke	Amino acid utilisation by *Oenococcus oeni* during malolactic fermentation of wine.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
H. Gockowiak, P.A. Henschke	Effect of inoculation timing on malolactic fermentation.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
P.R. Grbin[3,4], A.J. Markides[5], T.H. Lee[2,3], P.A. Henschke	Dependence of nitrogen source for the formation of mousy wine off-flavour N-heterocyclic compounds by *Dekkera* yeast.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
Y. Hayasaka	Characterisation of grape seed tannins by electrospray mass spectrometry.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
Y. Hayasaka, E.J. Bartowsky	Development of a simple and accurate analytical method for diacetyl in wine using SPME and GC-MS.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
Y. Hayasaka, K.F. Pocock, K.S Adams[5], E.J. Waters, R. van Heeswijck[5], P.B. Høj	The use of LC/ESI-MS to determine whether masses of haze-forming proteins vary among different grape varieties.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
D.D. Hills[9], P.A. Henschke, G.P. Jones[5], A.J. Markides[5]	The influence of yeast fermentation on the growth of *Oenococcus oeni.*	Tenth Australian Wine Industry Technical Conference, Sydney, NSW	2-5 August 1998
M.G. Holdstock, S.M. Weeks	Relationship between acetic acid and volatile acidity.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August 1998

Appendices

Appendix 1
External seminars, talks and poster papers presented by Institute staff during 1998/99

Author	Title	Organization/Location	Date
P.G. Iland[5], Z.K. Peng, G. Pfennig[5], C. Ford[5], P.B. Høj	Changes in the phenolic composition of Shiraz grapes during ripening.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
S. Kassara, P.J. Williams, I.L. Francis	Flavour release from glycosides remaining after fermentation.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
M.J. Kwiatkowski, S. Black[5], W.U. Cynkar, P.J. Williams, I.L. Francis	Changes in Glycosyl-Glucose (G-G) concentration of juices and musts during winemaking.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
D. Liacopoulos, G.K. Skouroumounis, A.P. Pollnitz, M.A. Sefton	Can 2,4,6-trichloroanisole (TCA) be formed post bottling and then contaminate wine?	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
A. Oberholster, S. Kassara, P.G. Iland[5], I.L. Francis	Routine methods to determine the complete polyphenolic profile of red wines.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
Z.K. Peng, P.G. Iland[5], Y. Hayasaka, G.P. Jones[5], E.J. Waters	Characterisation of grape seed tannins.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
Z.K. Peng, P.G. Iland[5], E.J. Waters	Effect of grape seeds on the phenolic profile of Shiraz wine.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
K.F. Pocock, E.J. Waters	The effect of mechanical harvesting and fruit transport on juice and wine protein instability.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
A.P. Pollnitz, D. Liacopoulos, P.J. Spillman, G.K. Skouroumounis, K.H. Pardon, G.P. Jones[5], M.A. Sefton	The analysis of oak derived flavour compounds in wine by stable isotope dilution.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August 1998
G.A. Ruediger, K.H. Pardon, R.L. Taylor	Miniaturisation of agrochemical residue analysis of grapes and wine.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW	2-5 August, 1998
G.K. Skouroumounis, Y. Kotseridis[16], R.L. Baumes[16]	Quantification of important aroma compounds in grapes and wines.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
A. Soden[2,3,7], T.H. Lee[2,3], P.A. Henschke	Cofermentation with *Candida stellata* and *Saccharomyces cerevisiae* affects wine composition.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
C.S. Stockley, B.L. Gulson, L.H. Smith, C. d'A. Osborn	Contribution of lead in wine from winemaking.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
A.P. Stubbs[5], J. Grubb[5], H. Gockowiak, P.A. Henschke, P.B. Høj, R. van Heeswijck[5]	Proline synthesis and distribution in mature berries of *Vitis vinifera.*	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
C.M. Sutherland, M.A. de Barros Lopes, P.R. Langridge[9], P.A. Henschke	Reducing hydrogen sulfide production by wine yeast.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
N.A. Yap, M.A. de Barros Lopes, P.R. Langridge[9], P.A. Henschke	Developing a wine yeast with broad spectrum zymocidal activity.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
E.J. Waters, K.F. Pocock, Z.K. Peng, M. McCarthy[15]	Unstable wine proteins are grape pathogenesis-related proteins and their expression is not induced by vineyard water stress.	Tenth Australian Wine Industry Technical Conference, Sydney, NSW.	2-5 August, 1998
S.M. Weeks	Activities of the Interwinery Analysis Group.	AOAC International Symposium, Montréal, Canada.	September, 1998
C.M. Sutherland, M.A. de Barros Lopes, P.A. Henschke, P.R. Langridge[9]	Reducing hydrogen sulfide production by *Saccharomyces cerevisiae* during wine fermentation.	XIX International Conference on Yeast Genetics and Molecular Biology, Rimini, Italy	25 - 30 May, 1999

Author	Subject/Location	Date
Workshops/Advanced Wine Assessment Courses		
A.N. Sas	Facilitate and present at the IPM: Research to Practice workshop at Albany, Western Australia.	31 August–1 September, 1998
A.N. Sas	Facilitate and present at the IPM: Research to Practice workshop at Margaret River, Western Australia.	3–4 September, 1998
P.A. Leske[18], N.G.C. Bruer, M. Gishen, J.B. Hughes, A. Loveys, S.M. Weeks, P.J. Graves	Advanced Wine Assessment Course, Waite Campus, Urrbrae, South Australia.	22-24 September, 1998
A.N. Sas	Facilitate and present at the IPM: Research to Practice workshop at Clare, South Australia.	6 October, 1998
A.N. Sas	Facilitate and present at the IPM: Research to Practice workshop at Nuriootpa, South Australia	8–9 October, 1998
A.N. Sas	Demonstrate the pesticide residue test kits produced from GWRDC-funded project AWR 97/1 to winery staff at: Buronga, New South Wales Angaston, South Australia Yenda, New South Wales Margaret River, Western Australia.	 10 November, 1998 11 November, 1998 17 November, 1998 30 November, 1998
P.A. Leske[18], N.G.C. Bruer, M. Gishen, J.B. Hughes, A. Loveys, S.M. Weeks, P.J. Graves	Advanced Wine Assessment Course, Waite Campus, Urrbrae, South Australia.	7-9 December, 1998

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Appendices

Appendix 1
External seminars, talks and poster papers presented by Institute staff during 1998/99

Author	Subject/Location	Date
A.N. Sas	Facilitate an IPM: Research to Practice workshop (third day) at Clare, South Australia.	11 May, 1999
A.N. Sas	Facilitate an IPM: Research to Practice workshop (third day) at Nuriootpa, South Australia.	12 May, 1999

[1] Rosemount Estates
[2] currently E&J Gallo, USA
[3] The Australian Wine Research Institute
[4] currently Charles Sturt University
[5] Department of Horticulture, Viticulture and Oenology, The University of Adelaide
[6] BRL Hardy Limited
[7] Lallemand Award + APRA(I) Award
[8] Cooperative Research Centre for Viticulture
[9] Department of Plant Science, The University of Adelaide
[10] currently Southcorp Wines
[11] currently Mildara Blass
[12] Department of Food Science, The University of New South Wales
[13] Grape and Wine Research and Development Corporation
[14] Dipartimento di Protezione e Valorizzazione Agroalimentare, University of Bologna, Italy
[15] Air Liquide Australia
[16] Laboratoire des Aromes at Substances Naturelles, INRA-IPV, France
[17] South Australian Research and Development Institute
[18] Nepenthe Vineyards
[19] South Australian Wine and Brandy Industry Association

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Appendix 2
Teaching responsibilities of Institute staff during 1998/99

Subject	No. of lectures	Institute staff
1998 – Semester 2		
The University of Adelaide		
1676 Research Project (Oenology) 6637 Research Project (HVO)	attending oral examinations	P.B. Høj
1958 Wine packaging and quality management	1 1	M. Gishen C.S. Stockley
2580 Stabilisation and Clarification	1	P.W. Godden
5153 Vineyard establishment	3	A.N. Sas
9685 Advances in Oenology	1 2 1	P.A. Henschke M.A. Sefton E.J. Bartowsky
9086 Advances in Oenology (Supplemented)	1 3 1	P.A. Henschke I.L. Francis E.J. Bartowsky
10918 Environmental Toxicology	1	G.A. Ruediger
International School of Hotel Management		
Wine Studies II	1	C.S. Stockley
1999 – Semester 1		
The University of Adelaide		
2213 Grape Industry Practice Policy and Communication	Subject coordination for seven weeks	P.B. Høj, C.S. Stockley
2580 Stabilisation and Clarification	3	E.J. Waters
2582 Biotechnology	1 1	P.B. Høj M.A. de Barros Lopes
5693 and 6319 Wine in Society	6	C.S. Stockley
The University of South Australia		
Bachelor of Business students, School of Marketing	1	C.S. Stockley

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Appendix 3
Graduate and Honours student supervision responsibilities of Institute staff for 1998/99

Student	Supervisor/s	Source of funds
Honours/Masters		
L. Brightman	I.L. Francis, P.B. Høj	The University of Adelaide
D. Coates	E.J. Bartowsky	The University of Adelaide
D. Crane	M.A. de Barros Lopes, A.S.J. Yap[2]	The University of Adelaide
M. Fogarty	P.A. Henschke, J.M. Eglinton, P.B. Høj	The University of Adelaide
S. Franke	M.A. Sefton, H. McLean[2]	The University of Adelaide
S. Lambert	G.P. Jones[2], I.L. Francis	The University of Adelaide
A. McKay	I.L. Francis, H. McLean[2]	The University of Adelaide
M. Trotter	M.A. Sefton, E.J. Waters, P.B. Høj	The University of Adelaide
PhD		
S.L. Brown	E.J. Waters, M.A. de Barros Lopes, P.B. Høj	GWRDC
F. Carrau	P.A. Henschke, E. Dellacassa[1]	University of the Republic of Uruguay staff
J.M. Eglinton	P.A. Henschke, P.R. Langridge[3]	Institute staff
R. Gawel	I.L. Francis, A.J. Markides[2]	DHVO staff
W. Greenrod	C.S. Stockley, M. Fenech[4], M. Abbey[4], P. Burcham[5]	GWRDC
A. Oberholster	E.J. Waters, I.L. Francis, G.P. Jones[2], P.G. Iland[2]	GWRDC
A.P. Pollnitz	M.A. Sefton, G.P. Jones[2]	Institute staff member
C. Smyl	P.A. Henschke, P.R. Langridge[3]	CRCV/Commonwealth PG award
V.J. Stockdale	P.J. Williams, E.J. Waters, G.B. Fincher[3]	Institute Award
C.M. Sutherland	P.A. Henschke, M.A. de Barros Lopes, P.R. Langridge[3]	CRCV
N.A. Yap	P.A. Henschke, M.A. de Barros Lopes, P.R. Langridge[3]	CRCV

Student	Title	Supervisor/s
PhD theses completed		
P.J. Costello	Formation of mousy off-flavour in wine by lactic acid bacteria.	P.A. Henschke, V. Jiranek[2]
A. Soden	The fermentation properties of non-*Saccharomyces* yeasts and their interaction with *Saccharomyces cerevisiae*.	P.A. Henschke, T.H. Lee[6,7], V. Jiranek[2]

1 University of the Republic of Uruguay, Uruguay
2 Department of Horticulture, Viticulture and Oenology, The University of Adelaide
3 Department of Plant Science, The University of Adelaide
4 CSIRO Human Nutrition
5 Department of Clinical and Experimental Pharmacology, The University of Adelaide
6 The Australian Wine Research Institute
7 currently E&J Gallo Winery, CA, USA
8 Deputy Vice Chancellor (Research), The University of Adelaide

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Appendix 4
Institute staff publications 1998/99

566 Gulson, B.L.; Stockley, C.S.; Lee, T.H.; Gray, B.; Mizon, K.J.; Patison, N. Contribution of lead in wine to the total dietary intake of lead in humans with and without a meal: a pilot study. J. Wine Res. 9: 5-14; 1998.

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578 Pocock, K.F.; Waters, E.J. The effect of mechanical harvesting and transport of grapes, and juice oxidation, on the protein stability of wines. Aust. J. Grape Wine Res. 4: 136-139; 1998.

579 Kosteridis, Y.; Baumes, R.; Skouroumounis, G. Synthesis of labelled [$_2H_4$] -damascenone, and [$_2H_2$]2-methoxy-3-isobutylpyrazine, [$_2H_3$] -ionone, and [$_2H_3$] -ionone, for quantification in grapes, juices and wines. J. Chromatogr. A:71-78; 1998.

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Appendix 5
Institute Committees

Staff member	Management Advisory	Research Steering	Industry Services Steering	Communication Steering	Analytical Service Steering	Information Technology	Biosafety	Occupational Health and Safety	Building Site	Building sub-committee	Super-annuation	Staff Code Negotiation
Peter Høj	C	C	X	X	X	C			X			X
Eveline Bartowsky						X		X				X
Rae Blair	X			C					X	C		
Nick Bruer	X		X		X			X				
Dimitra Capone								X				
Adrian Coulter	X		X		X							
Janet Currie	X										X	X
Catherine Daniel				X								
Miguel de Barros Lopes	X	X					X					
Jeff Eglinton				X		X	C					
Leigh Francis	X	X	X									
Mark Gishen	X	X	X		C							
Holger Gockowiak			X				X					
Peter Godden	X	X	C	X	X					X		
Carolyn Grant										X		
Jeremy Hack						X						
Yoji Hayasaka	X	X	X									
Paul Henschke	X	X			X			C				
John Hughes								X		X		
Ingrid Oats												X
Anita Oberholster								X				
Ken Pocock							X	X	X	X	X	X
Alan Pollnitz						X						
Alex Sas	X	X	X	X	X	X						
Mark Sefton		X										
Creina Stockley		X		X								
Elizabeth Waters	X	X					X					
Sue Weeks	X				X					X	C	

C = denotes holder of Chair

The staff of The Australian Wine Research Institute

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