Annual Report 1999

The Australian Wine Research Institute
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 1974. 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.
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45th Annual Report – 30th June 1999
Presented to the Australian Wine Industry
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 Hoj, 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 TSOQ-70 mass spectrometer with a new instrument, a TSOQ 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

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. Hoj
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
Mr P.A. Dunford
Mr F.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

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:

The Australian Wine Research Institute
Australian Wine and Brandy Corporation
Australian Wine Foundation
Charles Stuart 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 Hoj (Director).

Absent: Geoff Waunier.
Director’s report

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 be chiefly funded through accumulated and future income from our business activities and through a $575,000 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. 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 Boxer 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 within 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 into Industry is probably one of the most effective means of extension available to us.

Peter Høj
Director

Upgraded facilities at The Australian Wine Research Institute

P. Høj

The 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 Resources 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 photograph). 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 large 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, De 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 $575,000 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. 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 Boxer 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 into Industry is probably one of the most effective means of extension available to us.

Peter Høj
Director
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 acetic 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 relatively high acetic acid concentrations up to 2 g/l.

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

7. Institute staff co-authored 50 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 of 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 Bifl flavonoid 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.


14. At the Ninth 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.

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

16. Dr Mark Selfoot accepted the Wine Industry Innovation and Achievement Award for 1998 for his work involving ‘cork taint’.

17. The Director, Peter Hoj, 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 m², 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 150 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. Over 1200 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:

**Session 1 – Strategy 202 – how do we do it?**

- Dr John Stocker, Opening remarks
- Dr Paul van der Lee, The critical elements
- Nigel Streydl, France
- Developing Australia’s influence
- James Lovell, Internationalisation
- 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 today
- Robin Day, Challenges in the global market
- Bill Maidment, Australia: changing the Riverland image
- Robert Nicholson, USA
- Australia, the brand

**Colloquium: the next thirty years – are we ready?**

Moderator: Jeffrey Wilkinson

Keynote speaker: Phil Rutheven

**Session 3 – Resources**

- Chris Dandson, What have we got
- Nick Bullfield, Sites for style
- 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
- David Bruce, Case study – vineyard
- Sam Glactzer, 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 Sis, 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 Ian Preston, 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 Eldem 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 Mills, Pathways from laboratory to commercialisation

- current and proposed regulatory frameworks

Assoc: Professor Louane Slene

Consumer concerns, what are they and are they being addressed?

Coral 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 to the food industry

**Session 7 – Advances in Oenology**

- Dr Bruno Blondin, France
- Biotechnological 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
- Application of reverse osmosis in winemaking

**Session 8 – Advances in Viticulture**

- Peter Clinglefeffer, Holistic system approach for sustainable vineyard management for grape and wine quality
- Dr Giovanni Marcelli, Italy
- The impact of propagation on wine 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 Scholfield, 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 Selton, Cork lakes

Richard Gibson, Performance of synthetic stoppers

Geoff Linton, Bottling and corking – critical success factors

Nic Bulleid, Vineyard technology – what can we learn from other industries?

Vine manipulation to meet fruit specification

**Session 9 – Advances in Viticulture**

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Environmental management: the trends

Bob Newman

Environmental controls and options for management

David Bruce

Case study – vineyard

Sam Glactzer

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 Sis

Meeting a salt specification

Peter Godden

Measuring desirable oakwood components in wine

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 technologies
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.

From left: Maria Mills, Emma White and Narelle O’Costa
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 presentations, membership of external bodies, academic lectures delivered, graduate students supervised, and the papers published in the Institute’s journals is given in the external activities in support of the Institute performing a large number of external activities in support of the Australian Wine Industry.

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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 for many years, as well as from research studies (for example, see Institute publications numbers 127, 151, 233, 285, 285, 335), 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, there could be further potential benefit to the wine industry.

The Institute has been working collaboratively with Dr Bob Damberg (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 (NSW) 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.

### 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.

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

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Colours 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 this has the great advantage of giving virtually immediate results, with little analysis 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. Similarly, a reliable calibration has been obtained for pH (r=0.959).
The Australian Wine Research Institute

Research Teams’ reports

For future work with the colour, pH and total soluble solids 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.

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 5 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 grape

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 Selton) and sensory experts (Dr Leagh 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.

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.

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 Haj and Dr Paul Henschke. The initial results obtained by the investigators during the 1999 vintage have been further expanded during the 1999 vintage with technical assistance from Scott McWilliam.

> At 10°C Sacch. cerevisiae and Sacch. bayanus1 consumed 209 g/L sugar whereas Sacch. bayanus2 consumed 225-240 g/L.

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

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

> At 10°C all three yeast consumed 250 g/L sugar.
Sensory analysis of wines

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 was made. The wines made with Sacch. bayanus possessed 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 aroma compounds of wines were different from those of the reference yeast. The headspace of the wines was analysed using a panel of five highly experienced assessors. Data assessment is still in progress.

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 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 these species in commercial conditions.

Further research will be required to more accurately determine the nutrient requirements of Sacch. bayanus and to further understand the differences in concentrations of some known aroma compounds.

Conclusion

The wines made by fermenting Chardonnay grape juice with two strains of Sacch. bayanus contained 5- and 6-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, isoamyl alcohol, and ethyl octanoate (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.

Larger scale evaluation studies

The Sacch. bayanus strains are also undergoing preliminary trials under small-scale winery conditions at The University of Adelaide’s Hindmarsh 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 yeast.

Selection of wine yeast and malolactic bacteria for desirable glucosidases 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 precursors compounds exist as glucosides. These compounds, being non-volatile do not contribute to wine aroma until subjected to acid or enzyme catalysed hydrolysis. Currently, there are no commercially available preparations are available for addition to musts and wine for enhancing the flavour properties of wine, such as monoterpenes (Hagan 1997-AWSO Seminar, Melbourne). The aim of this project was to systematically identify and characterise wine yeast and bacteria with glucosidase 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 Institute with Dr Chris Steel and Paul Henschke as project supervisors from the Institute.

The focus of this subproject has been redirected in the light of recent developments coming out of Charles Sturt University and the Institute. The glycosidic activity of yeast, as determined by an artificial glucoside, was confirmed with an isolated authentic grape glucosidic fraction. However, substantial differences were noted with the two substrates tested.

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- Up to 80% of the G-G content of the grape glucosidase fraction was reduced by yeasts in a chemically defined fermentation medium.

- The kinetics of glucosidase 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 comparative studies.

Nitrogen and oxygen metabolism of yeast

Staff: Dr Grzegorz Gockowiak, Jeffrey Eglington, Paul Henschke

The Australian Wine Research Institute (Charles Sturt University while the G-G assays were redirected in the light of recent developments coming out of Charles Sturt University and the Institute.

From left: Jeff Eglington, Peter Costello and Holger Gockowiak

The Australian Wine Research Institute

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Molecular improvement of wine yeast

Staff: Miguel de Barros Lopes, Paul Henschke, Eveline Bartowsky, Holger Gockowiak, Peter Costello

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, 352, 565 and 589. The objective was to develop a molecular technique for identifying both Saccharomyces cerevisiae and non-S. cerevisiae wine yeasts 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. Saccharomyces cerevisiae 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 EC118 (EC118-GPD2). Glycerol 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 EC118. 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 Egloff as part of a PhD project under the supervision of Dr Peter Langridge, Department of Plant Science. The University of Adelaide and 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 ALD protein reduces acetic acid production when glycerol synthase is overexpressed.

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 catalysed by lactic acid bacteria. Our initial aim of this project is, therefore, to improve our understanding of the physiology of diacetyl metabolism in lactic 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 sub-project 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 culturing 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 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% CO2 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 vitamins, 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 modelling the MLF.

> Published media for modelling 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.
Research Teams’ reports

Microbial spoilage of wine by acetic acid bacteria
Staff: Eveline Bartowsky, Professor Graham Fleet (UNSWS) 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 acetic acid, 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 sulfur, has not been membrane filtered, and is 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 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.

> 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 bacteria, 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 bacteria has assisted a winery to implement measures designed to reduce the incidence of microbially induced oxidative spoilage of bottled red wine. However, the present trial is constrained to white fermentations. The results and conclusions of the completed experimental work were documented in the previous Annual Report. A summary of this work, entitled Restoring 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, Restoring 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 396).

Nitrogen composition of grape juice: analytical methods
Staff: Bogut Gackowski, Mark Gishen, Dr Robert Dambergs (BRL Hardy), Russell Johnston (Orlando Wymynham), 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 (OIA/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 Wymynham for evaluating NIRS as a rapid technique for juice nitrogen quantification.

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

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 microorganisms 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, Yui Hayashi, Stella Kataria, Mariia Kwiatkowski, Gayle Baldock

The Glycosyl-Glucose (G-G) assay
As discussed in previous annual reports, the G-G assay quantifies the amount of glycopolysaccharide 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 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

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and from research trials from the 1990 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 sensory intensity 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 white berry samples when a standard UV-visible spectrophotometer is used for accurate 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 sensory intensity scores.*

> *The analysis of non-phenolic glycosidic 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 utilize the G-G assay as an indicator of potential and actual wine quality.

**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.

**Development of an accurate, rapid analytical method for the quantification of key wine aroma 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 –somocone (violet), and 2-methoxy-3-isobutylpyrazine (vegetative, capsicum-like) have been targeted initially. The isopically labelled compounds are relatively straightforward to synthesise, the methods having been developed by George Skousenoussis, and to date labelled analogues of –damascenone and –somocone have been produced, as a result of the work of the newly appointed Josephine Newton.

The isopically 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 flavoured and cork taint compounds. In a complementary aspect to this work, isopically labelled analogues of fermentation-derived aroma 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 cooperation on wine composition**

> *Stefan Scholz, Alan Pattott 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 trials, and also in a range of bottled products.

> *The mean concentration of 4-ethylphenol in these shaved barrels was 35 µg/L, less than half the concentration found in wine in the new barrels.*

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

> *Oak variety (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 481 µg/L in the French oak wine and 446 µg/L in the American oak wine).*

> *There was no significant difference between the 4-ethylphenol concentrations 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-fined 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 in 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-ethylphenol.*

Effects of heating on extraction of flavour compounds from oak

Experimental work for a study, part of which was carried out in collaboration...
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 that has been heated. 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 woodlot. 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 extractable 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 barriques slows the rate at which wine will extract oak lactones from those barriques.

With oven heating, the concentration of most volatile oak components increased uniformly throughout the depth of the stave with increasing heating time and temperature. However, the increase in varietal 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.
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Research Teams’ reports

Elizabeth Waters, George Skouroumounis, (Peter Gambetta),
measurements of the (Michael Farmillo),
Mark Sefton, Yoji Hayasaka, Alan Pollnitz (Ben Riggs), met in February and
Jim Brayne),

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browning. In addition, there have been
making such wines more susceptible to
It is possible that particular winemaking
is done by
liquid. A rapid method is needed as
currently we can only indirectly measure
clear, the oxygen permeation, and this is done by
bottling wine and waiting six to 12 months before performing analyses to determine
dissolved oxygen (DO) and ethane and
levels. This process is slow, the analyses are expensive and, due to the complex
nature of wines, cannot be directly related to the
amount 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 the system must 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
cocks 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 transport through a cork inserted into 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 (institute publication 577) has suggested that
acetic acid addition to wines could be making such wines more susceptible to
browning. In addition, there have been

reports from Industry that upgrated stores of bottles exaggerate the
oxidation problem.

A trial to examine the effect of acetic acid and bottle position on oxidation and
sensory characterisation is now being carried out in collaboration with Prof Blair
Duncan, Southcoast Wines. A wooded Chardonnay wine will be bottled with and
without acetic 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
impact of wine type and oxygen concentration on the role of acetic 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 Saffn, Yoji Hayasaka, Alan Pollnitz and Dimitra Capone

The transmission of TCA (2,4,6 trichloroanisol) 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 synthetic) were obtained from a variety of suppliers, and had a variety of bleaching
treatments. Most of the 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 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 magnificently 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.

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
water, 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.

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 use of ‘e-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 Poszec, Yoji Hayasaka, Stella Kazaz, Anita O’berholtzer, Gayle Baldwin

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

The Industry Reference Group (IRG): The IRG, comprising personnel from the following industry members: Balocco of Coonawarra (Peter Bissel), BRL Hardy (Steve Farrell), Boors Rock Winery (Michael Farrell), Henschke Wines (Stephen Henschke), McWilliam’s Wines (Jim Brayne), Moara Blais (Nigel Dolan), Moss Wood Winery (Keith

Development of sensory methods to determine the structure of monomeric, oligomeric and polymeric pigments and procyanidins in wines
Mass spectrometric methods to characterize pigments and tannins are being further developed and refined.

Investigations using electrospray ionisation (ESI) and assisted laser desorption ionisation time of

From left: Alan Pollnitz, Dimitra Capone and Daniel Sajer

Mugford), Napseatue Wines (Peter Luka), Orlando Wyndham (Peter Gambetta), S. Smith & Son (Simon Adams), Southcrop Wines (Peter Taylor), Wine Network Australia (Gary Baldwin) and Wirra Wirra (Ben Rigg), 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

identified here.

MossWood Winery

Robert Asenstorfer

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Expected outcomes
- A set of attributes 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 pigment (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 different viticultural areas and made into wines. Temperature and added SO2 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 hydrolysis 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.

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, intermolecular 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 reaction. 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 outcomes
- A knowledge of the structure 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 presented as posters at the Tenth Australian Wine Industry Technical Conference.
### Research Teams’ reports

#### Expected outcomes

- An understanding of the different winemaking practices that may be used to manipulate the tannin composition and the mouthfeel property of these tannins in wine.

- Recommendations to Industry for winemaking practices to produce wines of a desired quality and end use.

#### Waite Campus Mass Spectrometry Facility

**Staff:** Yip Hayashiya and Gayle Balland

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 56% and 57% for AWRI, 58% 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 other 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, haize and 4-ethylphenol (one case each).

- The Institute is increasingly relying on advanced GC-MS and LC-MS analysis 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 ethyl carbamate in wine.

- A GC-MS based method for the accurate analysis of ethyl carbamate at ppt levels in wine has been established. This analysis is now offered by the Institute’s Analytical Service.

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:

#### Industry Services Teams’ reports

**From left:** Peter Godden and Wiss 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.

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#### Technical problem solving and consultation

**Staff:** Peter Godden, Adrian Coulter, Mark Gihen, 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 QFORD-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 foreseen 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.

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 Forncron 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 Consultative and Investigative and Advisory Services are supported by vineyard and winery visits and seminar tours to all major growing regions, generally organised in conjunction with local grapegrowers’ 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 grape, wine and vines’, which will include speakers from Australia, New Zealand and Italy. In addition, the Symposium will include a number of quality management workshops, which is being organised by the Quality Liaison Manager, Mark Gishen, with assistance from the Team Manager.

The Industry Services Laboratory maintains a QFORD-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 Industry Services Teams’ reports

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

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

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

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Wineries</td>
<td>769</td>
<td>853</td>
<td>980</td>
</tr>
<tr>
<td>Government organisations</td>
<td>76</td>
<td>114</td>
<td>70</td>
</tr>
<tr>
<td>Other</td>
<td>432</td>
<td>396</td>
<td>419</td>
</tr>
<tr>
<td>Students</td>
<td>44</td>
<td>33</td>
<td>35</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1321</strong></td>
<td><strong>1396</strong></td>
<td><strong>1504</strong></td>
</tr>
</tbody>
</table>
A major comparative trial, which will examine the technical performance of various types of wine closure and define consumer acceptance of various closure types. The full trial protocol was published in wine than in juice. During the year, work has progressed on the Multi Residue Assay (MRA) for the determination of ethyl carbamate in white and red wine by GC/MS; and application of the Multi Residue Assay (MRA) for the determination of ethyl carbamate during the wine-making 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 Kerritt, 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 field trials for the validation of test kits for several commonly used agrochemicals, including carbendazim, iprodione, metalaxyl and carbendazim.

Work on CRV-funded trials examining the fate of agrochemical residues during the winemaking process and subsequent wine storage was undertaken. 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 analytical fermentation losses, and the white wine primary-fermentation trial was expanded to include juice setting. Fruit for the red and white wine primary-fermentation trials, was sourced from an organically managed vineyard, so as not to contain any agrochemicals. The bunches were then individually sprayed with the agrochemicals which are the subject of the trial.

The continued assistance of the Institute’s Viticulturist, Lexi 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 in Glass program, which was published in August 1997. Two more companies have undertaken the program, with one of these already successfully obtaining certification. One company from an earlier era 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 points) quality and safety plan that will encompass the requirements of the proposed changes to the food hygiene regulations and meet the needs of the analytical 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 grape growing through to bottling. The resulting draft program was further developed in a pilot project with a group of winemakers in Victoria with some financial assistance from Business Victoria. The resulting program is both a more complete and cheaper program that uses a staged approach in the attainment of internationally recognised standards, stemming from the United 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 is envisaged under the Code 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 in 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 are assessing 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-reduction 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 indicate some improvements in many areas including audit scheduling, and quality control checks in the processing system. 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 manual are currently being reviewed and 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 GWRI-funded project, AWR 99/2 Analysis of quality parameters in grapes and wine using Near Infrared Spectroscopy (NIRS) elsewhere in this Annual Report.

Provision of technical information
Staff: Peter Goldden, Catherine Daniel, Ingrid Gatts and Sam 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 a cost-recovery basis. The cost of an online search depends on the complexity of the subject and may range from $50
outwards. 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.

**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 *Aprodenials* register 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 18,000 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 CWREC 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 winemakers 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 Crema Stockley, the Health and Regulatory Information Manager and is partially supported by The Thomas Walter Hardy Trust Fund.

**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 in-house technical information ser

### Table 3. Summary of information requests during 1998/99

<table>
<thead>
<tr>
<th>Service Type</th>
<th>Library catalogue databases</th>
<th>Information requests</th>
<th>Online database searches</th>
<th>Interlibrary loans</th>
<th>Technical Review requests</th>
<th>Technical Review articles forwarded</th>
<th>Article requests</th>
<th>Articles forwarded</th>
<th>Number of Institute publications forwarded</th>
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<td>1062</td>
<td>222</td>
<td>53</td>
<td>357</td>
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</tbody>
</table>

Note: 1. Number of requests received for articles published in the *Technical Review*.
2. Number of articles forwarded (usually more than one article is requested).
3. Requests received for articles published in the *Technical Review* library or database.
4. Number of articles forwarded, excluding staff publications (usually more than one article is requested).
5. Staff at the JFML sent a request to another library for an article.
6. Requests received by the JFML from other libraries for articles from our collection.
7. Number of requests received for articles published in the JFML library or database.
8. Number of articles forwarded (usually more than one article is requested).

**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).

**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 or journals is acknowledged: Australian Bureau of Agriculture and Resource Economics, Australian-Dried Fruits Corporation, Australian Wine and Brandy Producers’ Association, Commonwealth Scientific and Industrial Research Organization, K.F. Poocock, D.J. McWilliam, Dr B.C. Rankine, Dr J. Spawar, Dr J. Spooner, The University of Adelaide, Viticultural Publishing Inc., Winemakers’ Federation of Australia Incorporated.

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.

The Australian Wine Research Institute

The John Fornachon Memorial Library

Endowment Fund

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The Australian Wine Research Institute
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 widespread. 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 benefit 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 winemakers and grapegrowers with the selection of pest and disease control strategies that minimise the risk of unwanted chemical residues in wine.

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 products, 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, Envirotech, 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 b-monthly publication, Technical Review;
- participation in the Institute’s ‘Roadshow’ visits to Western Australia (see Appendix 1); and
- coordination of poster display at the 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 Stodley

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 Youth Alcohol Strategy of the Federal Department of Health and Family Services;
- Review of the recommendations regarding responsible drinking in 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

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:

- H 97/2 – Potential cardioprotective activities of wine components based on synergistic interaction with vitamin E. Principal Organisation: Heart Research Developments Pty Ltd.

Staff: Dr Roland Stoeker, Covan 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 10.5% (w/w) cholesterol; these mice are an animal model commonly used for atherclerosis, 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 garage 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 was measured 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 1, or a component thereof. Thus, the administration of de-alcoholized red wine or white wine Fraction 1 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 ± 1.3 mmol (control) to 1.0 ± 0.3 mmol (de-alcoholised red wine; p = 0.0012) and 1.3 ± 0.1 mmol (white wine Fraction 1; p = 0.0012), though alcoholised red wine and white wine Fraction 1 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 and were associated with larger animal numbers, they could indicate a potential protective activity of de-alcoholized wine or wine Fraction 1 against cardiovascular events, particularly if the decrease in the plasma concentration of cholesterol was associated with the decrease in the concentration of GSH-pyruvate (that is, a 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 constituent of LDL.

-tocopherol was monitored as an indicator of tocopherol lipoprotein; Committee of Management, Dr Kevin Croft, Associate Professor Ian Podany, Professor Laurie Bollin, 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 in vivo, however, were not conclusive. Therefore, a longer-term, cross-over intervention study was conducted to measure F2-isoprostanes, which are currently the best available biomarker of lipoperoxidative 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 F2-isoprostanes was measured. Serum -TG was monitored as an indicator of alcohol consumption and urinary 3-methylnicotinic acid, a major metabolite of gallic acid, was measured as an indicator of the absorption of phenolic acids. The plasma concentration of F2-isoprostanes (p<0.05) decreased significantly with de-alcoholised red wine as compared with the alcohol-containing beverages. The urinary concentration of F2-isoprostanes (p<0.05) decreased significantly with de-alcoholised red wine when compared with red wine (p<0.05). The concentration of -TG decreased significantly with de-alcoholised red wine and increased with alcohol-containing beverages (p<0.0005). The urinary excretion of 4-O-methylgallicate 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 cancelled by the pro-oxidant effects of the ethanol component.

• CSIRO’s Reduction of damage to LDL and DNA from oxidative free radicals by the regular and moderate consumption of alcoholic beverages: CSIRO Division of Human Nutrition.

Staff: Will Greenrod

Will Greenrod, the appointed PhD candidate, commenced work on this project in June 1999. 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 micronuclei (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 gamma-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.

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 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. Analysis 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 affect consumer attitudes and consumption of wine, in conjunction with the Department of Agriculture, 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

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Industry Services Teams’ reports

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. 16 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 Chair Economic Relations Trade Agreement of 1985 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 and the Government of New Zealand establishing a Agreement between the Government of Australia and New Zealand standards for of a draft standard. The current statutory position and other papers have been submitted 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.

From left: Randall Taylor, Jeremy Hack and Matthew Cream

Analytical Service
Staff: Sue Wools, Sue Hughes, Matthew Holdstock, Greg Ruehdiger, Gayle Baldock, Amanda Cook, Matthew Cream, Adam Fisher, Peter Graves, Jeremy Hack, Radka Kalsch, Andrea Kemp, Adam Lowery, 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 ‘Analyst 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...
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 Hoj
Director

Abridged Accounts of the Financial Report for Year Ended 30th June 1999

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

<table>
<thead>
<tr>
<th>1999</th>
<th>1998</th>
</tr>
</thead>
<tbody>
<tr>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>Income</td>
<td></td>
</tr>
<tr>
<td>Grants received</td>
<td>3 511 128</td>
</tr>
<tr>
<td>Interest</td>
<td>60 752</td>
</tr>
<tr>
<td>Other Income</td>
<td>1 038 765</td>
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<tr>
<td>Total Income</td>
<td>4 590 645</td>
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<td>Expenditure</td>
<td></td>
</tr>
<tr>
<td>Staff</td>
<td>2 496 439</td>
</tr>
<tr>
<td>Travel</td>
<td>95 359</td>
</tr>
<tr>
<td>Amortisation and depreciation</td>
<td>275 466</td>
</tr>
<tr>
<td>Operating and other expenditure</td>
<td>1 264 825</td>
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<tr>
<td>Total Expenditure</td>
<td>4 122 069</td>
</tr>
<tr>
<td>Operating Profit for the Year</td>
<td>468 576</td>
</tr>
</tbody>
</table>

Balance Sheet as at 30th June 1999

<table>
<thead>
<tr>
<th>1999</th>
<th>1998</th>
</tr>
</thead>
<tbody>
<tr>
<td>$</td>
<td>$</td>
</tr>
<tr>
<td>Current Assets</td>
<td></td>
</tr>
<tr>
<td>Cash on hand and at bank</td>
<td>228 072</td>
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<tr>
<td>Trade and other receivables</td>
<td>291 991</td>
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<tr>
<td>Short term deposits</td>
<td>621 000</td>
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<tr>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Total Current Assets</td>
<td>1 141 063</td>
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<tr>
<td>Non-Current Assets</td>
<td></td>
</tr>
<tr>
<td>Leasehold buildings</td>
<td>1 459 249</td>
</tr>
<tr>
<td>Plant and equipment</td>
<td>1 395 224</td>
</tr>
<tr>
<td>Chair of Oenology</td>
<td>840 000</td>
</tr>
<tr>
<td>Total Non-Current Assets</td>
<td>3 694 473</td>
</tr>
<tr>
<td>Total Assets</td>
<td>4 835 536</td>
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<tr>
<td>Current Liabilities</td>
<td></td>
</tr>
<tr>
<td>Accounts payable</td>
<td>578 714</td>
</tr>
<tr>
<td>Provision for employee entitlements</td>
<td>274 273</td>
</tr>
<tr>
<td>Total Current Liabilities</td>
<td>852 987</td>
</tr>
<tr>
<td>Non-Current Liabilities</td>
<td></td>
</tr>
<tr>
<td>Provision for employee entitlements</td>
<td>307 470</td>
</tr>
<tr>
<td>Total Non-current Liabilities</td>
<td>307 470</td>
</tr>
<tr>
<td>Total Liabilities</td>
<td>760 457</td>
</tr>
<tr>
<td>Accumulated Funds</td>
<td></td>
</tr>
<tr>
<td>Retained profit at the beginning of the year</td>
<td>2 036 686</td>
</tr>
<tr>
<td>Plus operating profit for the year</td>
<td>468 576</td>
</tr>
<tr>
<td>Retained profits at the end of the year</td>
<td>2 505 262</td>
</tr>
<tr>
<td>Asset evaluation reserve</td>
<td>603 067</td>
</tr>
<tr>
<td>Capital reserve</td>
<td>966 750</td>
</tr>
<tr>
<td>Total Accumulated Funds</td>
<td>4 075 079</td>
</tr>
</tbody>
</table>
## The Australian Wine Research Institute

### The Australian Wine Research Institute

**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
Signed at Adelaide this 26th day of October 1999.

### Abridged Accounts of the Financial Report

#### for Year Ended 30th June 1999

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cash Flows From</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grants and other income</td>
<td>4,433,588</td>
<td>3,982,286</td>
</tr>
<tr>
<td>Interest received</td>
<td>60,752</td>
<td>51,785</td>
</tr>
<tr>
<td>Payments to suppliers</td>
<td>3,385,027</td>
<td>3,301,225</td>
</tr>
<tr>
<td>and employees</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Net cash provided by</strong></td>
<td>609,313</td>
<td>712,846</td>
</tr>
<tr>
<td>operating activities</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **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**    | (784,019) | (454,133) |
| investing activities    |        |        |

| **Net increase (decrease)** |        |        |
| in cash held               | (174,716) | 258,715 |
| Cash at 1 July 1998        | 402,778 | 144,065 |
| Cash at 30 June 1999       | 220,072 | 402,778 |

| **Reconciliation of Net Cash** |        |        |
| Provided by Operating Activities with 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) |
| Changes in (reduction in) provisions | (45,682) | 34,475 |
| Changes in assets and liabilities: (Increase)/Decrease in receivables and prepayments | (77,469) | (2,534) |
| Increase in sundry creditors and accruals | 2,618 | 214,892 |
| **Net cash provided by** | 609,313 | 712,846 |
| operating activities |        |        |
## Appendices

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

<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Organization/Location</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.A. de Barros Lopes</td>
<td>Genetic improvement of wine yeasts</td>
<td>Faculty of Science and Agriculture, Charles Sturt University, Wagga Wagga, New South Wales</td>
<td>13 July, 1998</td>
</tr>
<tr>
<td>Z.K. Peng</td>
<td>Effect of grape seeds on the phenolic profile of Shiraz wine</td>
<td>Poster break-out presentation at the Tenth Australian Wine Industry Technical Conference, Sydney, NSW</td>
<td>4 August, 1998</td>
</tr>
<tr>
<td>A.N. Sas</td>
<td>Meeting a salt specification.</td>
<td>Tenth Australian Wine Industry Technical Conference, Sydney, NSW</td>
<td>4 August, 1998</td>
</tr>
<tr>
<td>J.M. Eglinton</td>
<td>Restarting stuck fermentations which contain high volatile acidity.</td>
<td>Poster break-out presentation at the Tenth Australian Wine Industry Technical Conference, Sydney, NSW</td>
<td>5 August, 1998</td>
</tr>
<tr>
<td>M. Gishen</td>
<td>Application of near infrared spectroscopy (NIRS) for assessment of grape quality</td>
<td>Poster break-out presentation at the Tenth Australian Wine Industry Technical Conference, Sydney, NSW</td>
<td>5 August, 1998</td>
</tr>
<tr>
<td>G.K. Skouroumounis</td>
<td>Quantification of important aroma compounds in grapes and wines.</td>
<td>Poster break-out presentation at the Tenth Australian Wine Industry Technical Conference, Sydney, NSW</td>
<td>5 August, 1998</td>
</tr>
<tr>
<td>C.S. Stockley</td>
<td>Wine and Health issues.</td>
<td>Somerton Park Probus Club, Somerton Park, South Australia</td>
<td>8 August, 1998</td>
</tr>
<tr>
<td>M.A. de Barros Lopes</td>
<td>Molecular mapping in yeast - what can it tell us?</td>
<td>Department of Plant Science, The University of Adelaide, Waite Campus, Urrbrae, South Australia</td>
<td>24 August, 1998</td>
</tr>
<tr>
<td>C.M. Sutherland</td>
<td>Genetic manipulation of wine yeast to reduce hydrogen sulfide production.</td>
<td>Department of Horticulture, Vitisculture and Oenology, The University of Adelaide, Waite Campus, Urrbrae, South Australia</td>
<td>2 September, 1998</td>
</tr>
</tbody>
</table>
### Appendices

#### Appendix 1

<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Organization/Location</th>
<th>Date</th>
<th>Author</th>
<th>Title</th>
<th>Organization/Location</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>M. Gishen</td>
<td>Near infrared spectroscopy (NIR) for assessment of grape quality.</td>
<td>Yintec '98, Penola: South Australia.</td>
<td>28 Oct, 1998</td>
<td>A.N. Sas</td>
<td>Managing and measuring phytyl and testing for chemical residues.</td>
<td>South Australian Farmers’ Federation, McLaren Vale Growers’ Day, McLaren Vale, South Australia</td>
<td>26 May, 1999</td>
</tr>
<tr>
<td>P. B. Høj</td>
<td>The importance of education and R&amp;D for the successful development of the Australian wine industry.</td>
<td>Royal Australian Chemical Institute’s annual general meeting, Cheddar Gells, Adelaide, South Australia</td>
<td>3 Nov, 1998</td>
<td>L.L. Francis</td>
<td>Tannins and the sensory properties of red wines.</td>
<td>International Workshop on Tannins in Livestock and Human Nutrition, Adelaide, South Australia</td>
<td>1 June, 1999</td>
</tr>
<tr>
<td>P.B. Høj</td>
<td>The generation and maintenance of a ‘learning and innovative culture’, a necessary investment and a critical element for the wine industry’s continued prosperity.</td>
<td>Rural Media Association’s meeting at the Hickinbotham Roseworthy Wine Science Laboratory, Waite Campus, Urrbrae, South Australia</td>
<td>12 Nov, 1998</td>
<td>E.J. Bartowsky</td>
<td>The microbiology of wine production.</td>
<td>School of Pharmacy and Medical Science, The University of South Australia, Adelaide, South Australia</td>
<td>2 June, 1999</td>
</tr>
<tr>
<td>M. Gishen</td>
<td>Approaches to yeast propagation and fermentation management: nutrition.</td>
<td>Presentation to NSW Wine Industry Association, Research and Development Committee, Sydney, NSW</td>
<td>11 Jan, 1999</td>
<td>P.J. Costello</td>
<td>Mousy off-flavour spoilage of wine by lactic acid bacteria.</td>
<td>VI International Oenology Symposium, Bordeaux, France</td>
<td>10-12 June, 1999</td>
</tr>
<tr>
<td>P.W. Godden</td>
<td>Winemaking in Australia</td>
<td>Japanese farmers, winegrowers and winemakers from the Kobe region, Plant Research Centre, Waite Campa, Urrbrae, South Australia</td>
<td>3 March, 1999</td>
<td>A.N. Sas</td>
<td>Meeting market specifications.</td>
<td>Government Service Delivery Caucus Committee, Waite Campus, Urrbrae, South Australia</td>
<td>17 June, 1999</td>
</tr>
<tr>
<td>P.B. Høj</td>
<td>Agriculture: Food and Wine (Chair of Session).</td>
<td>14th Australasian Biotechnology Conference, Glenelg, South Australia</td>
<td>22 Apr, 1999</td>
<td>P.J. Costello</td>
<td>1) Mousy off-flavour spoilage of wine by lactic acid bacteria; 2) Small-scale evaluation of L. direct inoculation bacteria strains for induction of malolactic fermentation.</td>
<td>Centro de Investigación y Desarrollo de Agrobiología (CIDA), Rioja region, Spain</td>
<td>14 June, 1999</td>
</tr>
<tr>
<td>L.L. Francis</td>
<td>Grape berry quality measurements: recent developments.</td>
<td>Margaret River Field Day Seminar, Margaret River WA</td>
<td>7 May, 1999</td>
<td>P.J. Costello</td>
<td>1) Mousy off-flavour spoilage of wine by lactic acid bacteria; 2) Small-scale evaluation of L. direct inoculation bacteria strains for induction of malolactic fermentation.</td>
<td>Navarra Viticulture and Oenology Centre (EVENA), Northern Spain, Spain</td>
<td>15 June, 1999</td>
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<td>A.N. Sas</td>
<td>Meeting market specifications.</td>
<td>Government Service Delivery Caucus Committee, Waite Campus, Urrbrae, South Australia</td>
<td>17 June, 1999</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>P.J. Costello</td>
<td>1) Mousy off-flavour spoilage of wine by lactic acid bacteria; 2) Small-scale evaluation of L. direct inoculation bacteria strains for induction of malolactic fermentation.</td>
<td>Centro de Investigación y Desarrollo de Agrobiología (CIDA), Rioja region, Spain</td>
<td>14 June, 1999</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>L.L. Francis</td>
<td>Using agrochemicals, selling wine.</td>
<td>School of Pharmacy and Medical Science, The University of South Australia, Adelaide, South Australia</td>
<td>2 June, 1999</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>P.A. Henschke</td>
<td>Yeast nutrition and fermentation management.</td>
<td>C.A. Henschke &amp; Co., Keyneton, South Australia</td>
<td>11 June, 1999</td>
</tr>
</tbody>
</table>
Appendices

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

<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Organization/Location</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>M. Gishen, L. Bowes</td>
<td>Implementing quality management systems with less pain—from topic to glass.</td>
<td>Tenth Australian Wine Industry Technical Conference, Sydney, NSW.</td>
<td>2-5 August, 1998</td>
</tr>
</tbody>
</table>
### Appendices

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

<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Organization/Location</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. Laiopoulos, G.K. Skouroumounis, A.P. Pollnitz, M.A. Setton</td>
<td>Can 2,4,6-trichloroanisole (TCA) be formed post bottling and then contaminate wine?</td>
<td>Tenth Australian Wine Industry Technical Conference, Sydney, NSW</td>
<td>2-5 August, 1998</td>
</tr>
<tr>
<td>C.M. Sutherland, M.A. de Barros Lopes, P.A. Henschke</td>
<td>Reducing hydrogen sulfide production by Sarracenia purpurea during wine fermentation.</td>
<td>XIX International Conference on Yeast Genetics and Molecular Biology, Rimini, Italy</td>
<td>25-30 May, 1999</td>
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</tbody>
</table>

### Workshops/Advanced Wine Assessment Courses

<table>
<thead>
<tr>
<th>Author</th>
<th>Subject/Location</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.N. Sas</td>
<td>Facilitate and present at the IPM: Research to Practice workshop at Albany, Western Australia</td>
<td>51 August – 1 September, 1998</td>
</tr>
<tr>
<td>A.N. Sas</td>
<td>Facilitate and present at the IPM: Research to Practice workshop at Margaret River, Western Australia</td>
<td>3-4 September, 1998</td>
</tr>
<tr>
<td>A.N. Sas</td>
<td>Facilitate and present at the IPM: Research to Practice workshop at Clare, South Australia</td>
<td>6 October, 1998</td>
</tr>
<tr>
<td>A.N. Sas</td>
<td>Facilitate and present at the IPM: Research to Practice workshop at Nairn Hopeo, South Australia</td>
<td>8-9 October, 1998</td>
</tr>
<tr>
<td>A.N. Sas</td>
<td>Demonstrate the pesticide residue test kits produced from GWRDC-funded project AWR 97/1 to winery staff at: Buronga, New South Wales</td>
<td>10 November, 1998</td>
</tr>
<tr>
<td></td>
<td>Angaston, South Australia</td>
<td>11 November, 1998</td>
</tr>
<tr>
<td></td>
<td>Yenda, New South Wales</td>
<td>17 November, 1998</td>
</tr>
<tr>
<td></td>
<td>Margaret River, Western Australia</td>
<td>50 November, 1998</td>
</tr>
</tbody>
</table>
Appendices

**Appendix 1**

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

<table>
<thead>
<tr>
<th>Author</th>
<th>Subject/Location</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.N. Sas</td>
<td>Facilitate an IPM: Research to Practice workshop (third day) at Clare, South Australia.</td>
<td>11 May, 1999</td>
</tr>
<tr>
<td>A.N. Sas</td>
<td>Facilitate an IPM: Research to Practice workshop (third day) at Nuriootpa, South Australia.</td>
<td>12 May, 1999</td>
</tr>
</tbody>
</table>

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 + APBA(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 Naturellles, INRA-IPV, France  
17. South Australian Research and Development Institute  
18. Nepenthe Vineyards  
19. South Australian Wine and Brandy Industry Association

**Appendix 2**

Teaching responsibilities of Institute staff during 1998/99

<table>
<thead>
<tr>
<th>Subject</th>
<th>No. of lectures</th>
<th>Institute staff</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1998 – Semester 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The University of Adelaide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1676 Research Project (Oenology)</td>
<td>attending oral examinations</td>
<td>P.B. Hoj</td>
</tr>
<tr>
<td>6657 Research Project (HVO)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1958 Wine packaging and quality management</td>
<td>1</td>
<td>M. Gishen</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>C.S. Stockley</td>
</tr>
<tr>
<td>2580 Stabilisation and Clarification</td>
<td>1</td>
<td>P.W. Godden</td>
</tr>
<tr>
<td>5153 Vineyard establishment</td>
<td>3</td>
<td>A.N. Sas</td>
</tr>
<tr>
<td>9685 Advances in Oenology</td>
<td>2</td>
<td>P.A. Henschke</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>C.S. Stockley</td>
</tr>
<tr>
<td>9886 Advances in Oenology (Supplemented)</td>
<td>5</td>
<td>I.L. Francis</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>E.J. Bartowsky</td>
</tr>
<tr>
<td>10918 Environmental Toxicology</td>
<td>1</td>
<td>G.A. Ruediger</td>
</tr>
<tr>
<td>International School of Hotel Management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wine Studies II</td>
<td>1</td>
<td>C.S. Stockley</td>
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### Appendices

#### Appendix 3

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

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<th>Student</th>
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**PhD Theses completed**

- **P.J. Costello**
  - Formation of mousy off-flavour in wine by lactic acid bacteria.
  - Supervisor: P.A. Henschke, V. Jiranek

- **A. Soden**
  - The fermentation properties of non-Saccharomyces yeasts and their interaction with Saccharomyces cerevisiae.
  - Supervisor: P.A. Henschke, TH. Lee, V. Jiranek

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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
### Appendix 5

#### Institute Committees

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<th>Management Advisory</th>
<th>Research Steering</th>
<th>Industry Services Steering</th>
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*C = denotes holder of chair*
The staff of The Australian Wine Research Institute

Acknowledgements:
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