State Government Victoria Department of Primary Industries

Australian Government
Grape and Wine Research and Development Corporation

Strategic development of next generation flavonoid analytical technologies for the Australian wine industry through innovation and collaboration



FINAL REPORT to

GRAPE AND WINE RESEARCH & DEVELOPMENT CORPORATION

Project Number: **DPI 04/01**

Principal Investigator: **Mark Downey**

Research Organisation: **Department of Primary Industries**

Date: **October 2004**

Strategic development of next generation flavonoid analytical technologies for the Australian wine industry through innovation and collaboration.

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Abstract

Travel to the US was undertaken to meet key researchers in the fields of bunch exposure and flavonoid analysis to discuss current research projects, analytical methods and philosophical approaches, to compare results and explore opportunities for future collaborative research. Invaluable discussions were held with a number of fellow researchers in both bunch exposure and flavonoid chemistry and biochemistry. In addition, a number of new contacts were made and insight into many current research projects was gained. These discussions helped to identify where our respective projects might intersect and will help researchers at Primary Industries Research Victoria, Mildura Centre to develop new and collaborative projects with partners such as Oregon State University, UC Davis and E&J Gallo Wines. These collaborations will form a component of a new project for DPI-Mildura currently being developed by Dr. Mark Downey and Dr. Mark Krstic.

This travel also enabled Dr. Mark Downey to attend the XXII International Conference on Polyphenols (ICP2004) in Helsinki, Finland. Dr. Downey was invited by the Groupe Polyphenols to present the findings of recent research on flavonoids in winegrapes in a poster and oral presentation at the conference.

Executive Summary

The aim of this GWRDC-funded travel was to examine new and emerging technologies and philosophies directly related to improving analysis of the flavonoid contributors to grape and wine quality. Given the highly specialised nature of some of these technologies the travel also sought to explore opportunities for developing collaborative projects that would enable access to the technologies for the Australian grape and wine industries.

In January 2004 Dr. Mark Downey, DPI Mildura submitted two abstracts to the Groupe Polyphenols to be considered for presentation at the XXII International Conference on Polyphenols to be held in Helsinki, Finland during late August 2004.

Of these abstracts submitted, one was accepted for a poster, while the other was accepted for an oral presentation. Both were accepted for submission as a two-page communications to appear in the conference proceedings. These papers are also included here as Appendix 1.

Travel to the XXII International Conference on Polyphenols was arranged such that Dr. Downey was able to return via the United States of America. In the USA Dr. Downey took the opportunity to renew contact with research colleagues working in the fields of viticultural and flavonoid research. During the course of this visit, extensive discussions were held on the opportunities and logistics of developing collaborative projects with Oregon State University, Corvallis, Oregon and University of California, UC Davis. In addition, Dr. Downey also visited E&J Gallo Winery in Modesto California to examine to potential of developing a collaborative viticultural research project between E&J Gallo Wines and Primary Industries Research Victoria.

Background

Refer to Executive Summary.

Project Aims & Performance Targets

Project Aims

1. To reinforce DPI's strategic relationship with fellow researchers on bunch exposure and flavonoids and to view current research trials on exposure and grape quality.
2. To compare current analytical methods in flavonoid chemistry, discuss shortcomings and develop strategies for future analyses with fellow researchers in the United States.
3. To compare and discuss recent research results in bunch exposure and flavonoid analysis and to discuss current and future research directions in these fields.
4. Attend the XXII International Conference on Polyphenols (ICP2004) and present a poster and make an oral presentation at this conference.
5. Communicate the outcomes of these experiences to colleagues in viticulture and oenology at DPI and in Australia generally.

Performance Targets

Output	Performance Targets	Date
1. Attend the XXII International Conference on Polyphenols (ICP2004), present a poster, and make an oral presentation.	a). Present poster of recent research findings on tannin biosynthesis at ICP2004. b). Oral presentation of recent research finding on light sensitivity of flavonols at ICP2004. c). Attend ICP2004.	a). 25-28 August 2004; b). 25-28 August 2004; c). 25-28 August 2004.
2. Reinforce strategic relationships with fellow flavonoid researchers in the USA; discuss and plan future collaborative research.	a). Meet with Dr. Jim Kennedy and Jessica Cortell at Oregon State University working on tannin analysis and spatial variability in vineyards. b). Meet with Dr. Doug Adams and other viticultural researchers at University of California, Davis Campus. c). Meet with Drs. Nick Dokoozlian, Tom Pugh and Mike Cleary, viticultural and oenological researchers at E&J Gallo Wines, Modesto California.	a). 1-6 September 2004; b). 6-8 September 2004; c). 8-10 September 2004.

2. Discuss experimental approaches to separating the effects of light and temperature in bunch exposure research.	a). Meeting with Dr. Jim Kennedy (OSU); b). Meeting with Dr. Nick Dokoozlian (E&J Gallo Wines).	a). 1-6 September 2004; b). 8-10 September 2004.
3. Compare current analytical methods in flavonoid chemistry, discuss shortcomings and develop strategies for future analyses with fellow researchers in the United States.	a). Meeting with Dr. Jim Kennedy; b). Meeting with Dr. Doug Adams.	a). 1-6 September 2004; b). 6-8 September 2004.
6. Communicate the outcomes of these experiences to colleagues in viticulture and oenology.	a). DPI Travel Report submitted; b). GWRDC Travel Report submitted: c). Article submitted to an Australian wine and grape industry journal.	a). October 2004; b). October 2004; c). in prep. (see Appendix 1).

Method

Not applicable.

Results & Discussion

Travel Itinerary:

Sunday 22 August – Fly Mildura to Helsinki, Finland.

Monday 23 August – Arrive Helsinki, Finland.

Tuesday 24 – Saturday 28 August – XXII International Conference on Polyphenols.

Saturday 28 August – Fly Helsinki to London, UK.

Tuesday 31 August – Fly London to San Francisco, California, USA.

Tuesday 31 August – Fly San Francisco to Portland, Oregon, USA.

Tuesday 31 August – Drive Portland to Corvallis, Oregon.

Wednesday 01 – Monday 06 September – Oregon State University, Corvallis, Oregon.

Monday 06 September – Drive Corvallis to Portland, Fly Portland to San Francisco.

Monday 06 September – Drive San Francisco to Davis, California.

Tuesday 07 – Wednesday 08 September – UC Davis.

Wednesday 08 September – Drive to Modesto, California.

Wednesday 08 – Friday 10 September – E&J Gallo Wines, Modesto, California.

Friday 10 September – Drive Modesto to San Francisco, California.

Sunday 12 September – Fly San Francisco to Mildura.

Tuesday 14 September – Arrive Mildura.

Groupe Polyphenols meeting, Helsinki, Finland

The XXII International Conference on Polyphenols, organised by the Groupe Polyphenols, was held in Helsinki, Finland, 24-28 August 2004. This meeting covered six topics:

T1: Polyphenols, Human Nutrition and Health

T2: Polyphenols, Animal Nutrition and Health

T3: Biosynthesis of Polyphenols

T4: Chemistry of Polyphenols

T5: Polyphenols and Environment

T6: Polyphenols and Skincare (Aging)

The program included 12 plenary lectures, 40 oral presentations and 372 posters presented by delegates from 47 countries. The program of plenary speakers and oral presentations is attached (Appendix 2). Notable amongst the plenary lectures were those by Daniele Werck-

Reichart (The meta-hydroxylation of phenolic esters and amides: the missing link in the phenylpropanoid pathway), Vincent L. Chang (Monolignol biosynthesis and genetic engineering of lignin in trees), Victor de Freitas (Chemical transformations of anthocyanins yielding a variety of colours) and Dieter Treutter (Significance of flavonoids in plant resistance).

Outstanding amongst oral presentations were those by Stefan Martens (Biochemical properties of dioxygenases involved in flavonoid biosynthesis in parsley: an evolutionary aspect), Cyril Auger (Flavanols (catechin monomers, procyanidin dimers and trimers) absorption, metabolism and excretion in a rat model system following ingestion of a grape seed extract), Maarit J. Rien (Anthocyanin copigmentation reaction with phenolic acids), Paul-Henry Ducrot (New methodologies for the synthesis of proanthocyanidins), Kirsti Parikka (Deuteration of polyphenols for analytical and metabolic studies) and Patrick Trouillas (A theoretical study of reactivity of OH groups in quercetin and taxifolin: specificity of the 3-OH group).

Of the several hundred posters, many of those that were of particular interest fell into two broad categories; Polyphenols with relevance to viticulture and winemaking, and Polyphenol biosynthesis, however these are too numerous to mention individually here. A list of poster titles and primary authors is attached (Appendix 3).

In addition to viewing many high quality presentations, a number of excellent contacts were made. Prime amongst these was through Dr. Øyvind Andersen (Bergen, Norway) who had previously attended the International Workshop on Anthocyanins (IWA2004) held at Wirrina Cove south of Adelaide. Dr. Andersen had brought several members of his research group to the conference and many useful discussions were held with various members of the group. These included structure-function relationships of different groups of anthocyanins and how structure might effect extractability and stability of the anthocyanin. In addition, extensive discussions were also held on the stability of anthocyanins in different aqueous and organic solvents. This is an area of particular interest to Dr. Downey in his current research in developing analytical methods applicable to anthocyanins in wine and grapes.

This contact with Dr. Andersen's group has developed into a good scientific relationship that has the potential to develop into future collaborations. Dr. Andersen's research group has extremely strong analytical capabilities with few peers in the field of flavonoid identification.

Oregon State University, Corvallis

Travel to Oregon State University at Corvallis was primarily to meet with Dr. Jim Kennedy, currently Assistant Professor of Food Science & Technology. Jim was previously a post-doctoral fellow at the University of Adelaide, Department of Horticulture, Viticulture and Oenology (2000-2001). During that time, he developed a method for cleaving tannin polymers and identification of the subsequent monomers (Kennedy & Jones, 2001). This was a method that I used extensively during my PhD at the University of Adelaide (1999-2002) and Jim and I had many discussions on development and application of the method and interpretation of the data we were generating.

Since moving to Corvallis, Dr. Kennedy has maintained his association with grape and wine analysis and has developed an analytical method for determining molecular weights of tannin components using gel permeation chromatography (Kennedy & Taylor, 2003). Dr. Downey travelled to Corvallis to try this method and evaluate its applicability to current and future research in wine and grape tannins. The method does not give baseline separation of individual tannin components, however the average molecular weight of compounds at points in the elution profile can be calculated. From this data it is possible to estimate tannin polymer length. Based on the assumption that polymers are generally linear this is relatively easy in grapes. However, the nature of wine tannin polymers is unclear, although it seems likely that branched polymers are more common in wine than grapes. Drs. Kennedy and Downey discussed at length the possibility of separating individual tannin components utilising this technology and developed a number of strategies to approach this problem. It is thought that these strategies will be included in a future project proposal where developing analytical techniques would be a component of a larger project to examine grape and wine tannin composition.

In addition to these discussions on tannin analysis, Dr. Downey also had lengthy discussions with Dr. Kennedy and his graduate student Jessica Cortell on her current project examining spatial variability in Pinot Noir vineyards in Oregon. This is an area of considerable interest to Australian viticulture with increasing interest in precision viticulture. In this project Dr. Kennedy and Ms. Cortell have examined a range of vineyard variables from soil chemistry and physics to plant physiology across a number of sites. From these data they have identified areas of low, medium and high vigour and have made wine based on these groupings. The fruit and wine from these grouping was analysed for maturity indicators as well as several quality parameters including anthocyanin and tannin composition. Recent data from these trials has shown substantial differences in anthocyanins and tannins between areas of the vineyard with different levels of vigour. This approach is similar to that which Dr. Downey and Dr. Mark Krstic (DPI Mildura) propose to apply to understanding anthocyanin and tannin

variability in the field in warm climate viticulture. The approach of identifying site variability and using that variation rather than implementing field trials would enable a more comprehensive approach utilising resources currently devoted to establishing and maintaining field trials.

UC Davis

Travel to UC Davis had two purposes, the first of these was to renew contacts with fellow grape and wine researchers in the Department of Viticulture and Enology, Dr. James Wolpert, the Department Chair, Dr. Roger Boulton, Dr. Andrew Waterhouse, and Dr. Doug Adams. In addition, the visit provided an opportunity for Dr. Downey and Dr. Doug Adams to discuss Dr. Adams' tannin assay (Adams & Harbertson, 1999) and to prepare an article for an Australian wine industry journal on the use and usefulness of this method for winery application.

Upon arrival at UC Davis, Dr. Downey met with Dr. Adams for a brief discussion on the proposed article for an industry journal and compared experiences using the tannin precipitation assay. Dr. Adams revealed that his research group had applied this method to several hundred wines including those made from Cabernet Sauvignon, Pinot Noir and Zinfandel and were looking to apply the method to Syrah from the coming harvest. It was proposed to include a summary of some of these results in the mooted article as a useful comparison for the Australian industry.

Following this meeting Dr. Downey gave a presentation to the Department of Viticulture and Enology at UC Davis on his recent research with CSIRO Plant Industry (PhD Project, 1999-2002) and Primary Industries Research Victoria. This presentation was attended by the majority of the Viticulture and Enology faculty and graduate students and was well received with a lengthy discussion following the presentation. Subsequent to the presentation arrangements were made for more detailed discussions with Dr. Andy Waterhouse and John Thorngate on analytical approaches to anthocyanins and tannins in grapes and wine.

In the afternoon, Dr. Downey once more met with Dr. Doug Adams and discussed in greater detail much of their work on tannins in winegrapes. During this discussion the question of reduced extractability of tannins from seeds and skins (Downey *et al.*, 2003) was raised. The question of what could be the fate of those tannins, particularly in grape skins, that were not extracted into a strong organic solvent such as acetone. Dr. Adams had speculated that these tannins remained bound to the grape skins as Dr. Downey had earlier proposed (Downey *et al.*, 2003).

Having read this paper (Downey *et al.*, 2003) and having observed similar phenomenon in grape skins, Dr. Adams speculated about which cellular components may be involved in this reduced extractability. Subsequent trials by graduate students under Dr. Adams supervision identified cell walls as being able to precipitate significant amounts of tannin. It seems likely that this occurs post-crushing and may vary considerably between cultivar, site and season. Thus, a rapid assay of the tannin precipitating capacity of skins would be useful in understanding the relationship between grape and wine tannin content and composition. This is one aspect of research currently supervised by Dr. Adams, as is determining the particular cell wall fraction responsible for tannin precipitation.

In light of these observations, Dr. Adams and Dr. Downey discussed the relative extractability of anthocyanins from grape skins and their persistence in wines as is becoming apparent from the recent work of Marica Njegovan. Marica is an Honours student funded by DPI working under Dr. Downey's supervision on the GWRDC-funded Bunch Exposure project. Marica's recent research has shown that the composition of individual anthocyanins in the wine does not necessarily reflect that in the wine. Initially it was presumed that this represented differential extractability. However, the research described by Dr. Adams suggests that differential precipitation or participation in other reactions may also be involved. Based on these observations, the relationship between grape anthocyanin and tannin composition and that of the wine, not only appears much more complex, but there now exists added impetus to explore this relationship more thoroughly.

E&J Gallo Winery

The final destination of this travel was to the E&J Gallo Winery in Modesto, California to meet with Dr. Nick Dokoozlian. The aim of this visit was to discuss the areas of research that were of interest to the Australian grape and wine industry that were consistent with the research aims of E&J Gallo Wines and to develop plans for collaborative projects in these areas. Lengthy discussions were held with Dr. Dokoozlian while touring a number of vineyards and E&J Gallo winery facilities. These included their research winery as well as a "pilot" winery. At the "pilot" winery, small scale (approx. 5 US tons) wines are made from new cultivars to evaluate their potential for incorporation into current and future E&J Gallo product lines.

Dr. Dokoozlian was formerly a research and extension scientist with the University of California (UC Davis) situated at the Kearney Agricultural Centre, California. Dr. Dokoozlian

has recently accepted a position as Vice President of Viticultural Research with E&J Gallo Wines, based at their Modesto, California winery.

Discussions on potential project collaborations with Dr. Dokoozlian identified a number of areas of common interest. These included spatial variability and precision viticulture similar to the work conducted by Dr. Kennedy and Jessica Cotrell at Corvallis, as well as the proposed project currently being developed by Drs. Downey and Krstic at DPI-Mildura. It was envisaged in these discussions that initially a survey of anthocyanin and tannin content and composition be examined across a wide selection of the major red winegrape cultivars. This survey would encompass different sites and regions, and possibly also some different management practices, to gain an appreciation of the variability of tannins and anthocyanins components in these grape cultivars. The longer view would be to identify sites with different anthocyanin and tannin profiles and make wine from these fruit to examine how grape composition relates to wine composition with a view to developing a predictive model. Such a model from E&J Gallo's standpoint would be of considerable use in making winery streaming decisions at harvest. In addition to this outcome, it may also be possible to identify management practices that would produce particular anthocyanin and tannin profiles and thus be able to produce grapes to specification in the vineyard.

In addition to these project ideas, there were also extensive discussions on the development of real-time analytical methods for use both in the field and at the weighbridge to further facilitate more informed streaming decisions. Of these, rapid micro-HPLC analyses and infra-red and near infra-red analyses are the approaches currently in favour. Of considerable interest was the latest version of the Brimrose handheld infra-red "gun". Previously Drs. Downey and Krstic observed this technology at the ASEV meeting in Reno, Nevada (June 2003). At that time, the "gun" was capable of determining ºBrix, acid and pH in grapes. It was considered than that if this technology could also determine colour it would be extremely useful in both industry and research. The most recent version of this technology can indeed determine colour in grape berries, however the equipment needs to be calibrated for each cultivar. As yet it is uncertain of how long this calibration is valid for, nor whether calibration is required for different site and season. This work is one of the current research directions at E&J Gallo and the implications just in labour costs compared to regular "wet" chemistry of vineyard samples for the Australian industry are considerable. Furthermore, this portable infra-red technology allows for much larger non-destructive sampling to levels consistent with those suggested by Dr. Mark Krstic from his research on vineyard variability and sampling in the Winegrape Quality Project (CRCV 1.1.2; MIS No. 07666).

Recommendations:

Excellent opportunities exist for developing collaborative projects with research and industry partners in the US:

- Development of a collaborative project on spatial variability of quality parameters in the vineyard with Oregon State University at Corvallis (Dr. Jim Kennedy) that extends their recent experience with Pinot Noir to Cabernet Sauvignon and Shiraz. This project should involve E&J Gallo Wines (Modesto, California) as they have an keen interest in this area and have substantial resources in terms of both access to grower properties throughout California and the economic capacity to support large scale field trials.

  This project would also examine the variability of tannins across cultivars and across sites and seasons. The ability to gather this data both in the USA and in Australia in a single year would substantially enlarge the data set and more rapidly generate an overview of tannin variability in *Vitis vinifera*.

- Creation of a collaborative team to develop improved tannin analyses that would utilise the analytical skills of Dr. Jim Kennedy (OSU) and Dr. Doug Adams (UC Davis) and the economic resources of E&J Gallo (Dr. Mike Cleary). This project would aim to increase our understanding of the relationship between anthocyanins and tannins and other oenological components with a view to developing a predictive model for wine based on fruit composition.

- Development of a collaborative project between DPI-Mildura and E&J Gallo on real-time analysis of quality and non-destructive field sampling.

Outcome/Conclusion

The performance targets for this project were met and in many cases exceeded. Invaluable discussions were held with a number of fellow researchers in both bunch exposure and flavonoid chemistry and biochemistry. In addition, a number of new contacts were made and insight into many current research projects was gained. These discussions helped to identify where our respective projects might intersect and will help researchers at DPI-Mildura to develop future collaborative projects.

Appendix 1: Communication:

This visit involved communicating with researchers in from around the world on their experiences and results with flavonoid analysis. It also involved communicating Australian research results to international researchers involved in flavonoid analysis.

Upon return, a travel report was prepared and submitted to DPI and GWRDC. In addition, a joint article on tannin analysis is being compiled by Dr. Mark Downey (DPI-Mildura) and Dr. Doug Adams (UC Davis) for publication in an Australian wine industry journal.

Appendix 2: Intellectual Property

nil

Appendix 3: References

Adams, D.O. and Harbertson, J.F. (1999) Use of alkaline phosphatase for the analysis of tannins in grapes and red wines, *American Journal of Enology and Viticulture* **50**; 247-252.

Downey, M.O., Harvey, J.S. and Robinson, S.P. (2003) Analysis of tannins in seeds and skins of Shiraz grapes throughout berry development. *Australian Journal of Grape and Wine Research* **9**; 15-27.

Kennedy, J.A. and Jones, G.P. (2001) Analysis of proanthocyanidin cleavage products following acid-catalysis in the presence of excess phloroglucinol, *Journal of the American Chemical Society* **49**; 1740-1746.

Kennedy, J.A. and Taylor, A.W. (2003) Analysis of proanthocyanidins by high-performance gel permeation chromatography, *Journal of Chromatography A* **995**; 99-107.

Appendix 4: Staff

Dr. Mark Downey, Department of Primary Industries, Primary Industries Research Victoria, Mildura Centre.

Appendix 5: Additional Information

- XXII International Conference on Polyphenols (ICP 2004), published communications Downey *et al.* (Sub Appendix 1).
- Program of Plenary speakers and oral presentations at the XXII International Conference on Polyphenols (ICP2004) held in Helsinki, Finland, 25-28 August 2004 (Sub Appendix 2).
- Copy of poster titles and primary authors presented at the XXII International Conference on Polyphenols (ICP 2004)(Sub Appendix 3).

Appendix 6: Budget Reconciliation

GRAPE & WINE RESEARCH & DEVELOPMENT CORPORATION

Statement of Receipts and Expenditure - **FORM B**

For the year ending 30 June 2005

Trust Fund :	RESEARCH TRUST FUND	FUNDING	$5,000
Project No :	DNR 02/09	Salaries	
Grantee :	Mark Downey	Travel	$5,000
Title of Project :	Building strategic relationships with fellow researchers involved with bunch exposure and phenolic compounds in the US, and attendance at the 54th Annual ASEV Meeting in Reno, Nevada	Operating	
		Capital	
		Total Funding	$5,000

EXPENDITURE										
	Salaries		Travel		Operating		Capital		Total	
	$	¢	$	¢	$	¢	$	¢	$	¢
A Uncommitted (c/f 1 July)										
B Outstanding Commitments (c/f 1 July)										
C Refunds of funding										
D Cash Received From Trust Fund										
E Approved transfers (from Form C)										
F Cash available (A+B-C+D±E)										
G Expenditure			$5,000							
H Outstanding Commitments (30 June)										
I Total funds Committed (G-H)										
J Uncommitted (30 June) (F-I)										
K Other income (Paid to Trust Funds)										

Note: *Row B should be the same as Row H from the previous year and Row A the same as Row J from the previous year.*

Appendix 1.

XXII International Conference on Polyphenols, Helsinki 2004 – published communications

Cloning and Expression of *Vitis vinifera* BANYULS Homolog

Mark O. Downey[1], John S. Harvey[2] and Simon P. Robinson[2]
1. Primary Industries Research Victoria, Mildura Centre, PO Box 905, Mildura Vic. 3502, Australia
2. CSIRO Plant Industry, Horticulture Unit, PO Box 350, Glen Osmond, SA 5064, Australia
Corresponding author: Mark Downey, facsimile +61 3 5051 4548, email mark.downey@dpi.vic.gov.au

Abstract
A cDNA fragment with homology to the *BANYULS* gene (Accession No. AF092912) was isolated from *Vitis vinifera* L. cv. Shiraz berry skin. Only a single *BANYULS* gene was detected in Shiraz grape tissues, with the gene expressed in seeds, berry skins and leaves of the grapevine. *VvBANYULS* was transformed into *Nicotiana tabacum*. Plants expressing high levels of *VvBANYULS* in petals had lower anthocyanin and higher tannin levels than wild-type flowers. The pattern of *VvBANYULS* expression in the grape seed and skin as well as the altered anthocyanin and tannin levels in transformed tobacco suggest a role for *BANYULS* in tannin biosynthesis in grapevines.

Introduction
Most research on tannin biosynthesis has been restricted to the seedcoat of *Arabidopsis thaliana*. However, tannins occur in most higher plants, many of which are economically important crops, such as grapes. Further, most plants make a more complex array of tannins than observed in the seedcoat of Arabidopsis, forming large heterogeneous polymers in a range of tissues. In grapes, tannins occur in both the seedcoat and the skin of the berry (Downey *et al.*, 2003a) and play an important role in wine quality contributing to mouthfeel and colour stability (Glories, 1988). Tannins also have antioxidant activity (Rice-Evans *et al.*, 1997), identifying this class of compounds as potential neutraceuticals.

Tannin biosynthesis occurs as a branch of the flavonoid biosynthetic pathway and was originally considered to be the result of reductase action upon leucoanthocyanidins (Stafford, 1990) generating the flavan-3-ols, eg. catechin. An unidentified epimerase was considered responsible for the formation of the epicatechin isomer. *BANYULS*, a putative gene involved in tannin biosynthesis was identified by Albert *et al.* (1997; Devic *et al.*, 1999). This gene was later shown to encode a protein, anthocyanidin reductase (ANR), which converted cyanidin to epicatechin (Xie *et al.*, 2003). Independent research showed that expression of the gene encoding leucoanthocyanidin dioxygenase (LDOX) was also required for tannin accumulation and that LDOX preceded ANR in tannin biosynthesis in Arabidopsis (Abrahams *et al.*, 2003). Research in another system, *Desmodium uncinatum*, isolated a protein, leucoanthocyanidin reductase (LAR), which catalysed the reduction of leucocyanidin to catechin (Tanner *et al.*, 2003). The gene encoding this protein was cloned and function demonstrated in a recombinant system. Together these results suggest a model wherein tannin biosynthesis in Arabidopsis produces flavan-3-ols based on epicatechin stereochemistry via ANR encoded by the *BANYULS* gene, while in Desmodium leaves biosynthesis of the flavan-3-ol catechin is catalysed by LAR.

Grapevine tannins include both catechin and epicatechin derivatives. In seeds, flavan-3-ols comprise similar amounts of catechin and epicatechin terminal subunits and free monomers, (Downey *et al.*, 2003a). In grape skin, free monomer and terminal subunit composition is almost exclusively catechin. This research sought to clone the *BANYULS* gene in grapevines and compare the expression pattern of the gene with the flavan-3-ol accumulation pattern in both the seed and the skin of the grape. We also sought to demonstrate functionality of *VvBANYULS* by transformation into a plant not producing tannins, *Nicotiana tabacum*.

Materials and Methods
Shiraz grapes (*Vitis vinifera* L.) were sampled from fruit-set until harvest. Tannin composition was determined by HPLC after extraction in 70% acetone and acid-catalysed cleavage of polymers as described in Downey *et al.* (2003a).

Genomic DNA extraction, total RNA extraction and PCR conditions are described in Downey *et al.* (2003b). First strand cDNA synthesis was performed using the 3'-RACE adapter primer and Superscript II (Invitrogen Life Technologies) as recommended by the supplier. A cDNA fragment with homology to the *BANYULS* gene (Accession No. AF092912) was isolated from Shiraz berry skin immediately post-flowering. The 1017-basepair sequence, named *VvBANYULS*, encodes a protein of 339 amino acids. *VvBANYULS* has 66% homology to *AtBANYULS* at the nucleotide level and 83% amino acid similarity. Only a single *BANYULS* gene was detected in Shiraz tissues, with the gene expressed in seeds, berry skins and leaves of the grapevine. Expression of

VvBANYULS was quantified by real-time PCR normalised to the housekeeping gene Ubiquitin.

A construct of the CaMV 35S promoter coupled to the open reading frame of *VvBANYULS* was transformed into *Nicotiana tabacum*. Expression of *VvBANYULS* in transformed plants was determined by Northern analysis. Tannin accumulation in petals of transformed plants was determined using the tannin specific stain DMACA (Li *et al.*, 1996).

Results and Discussion

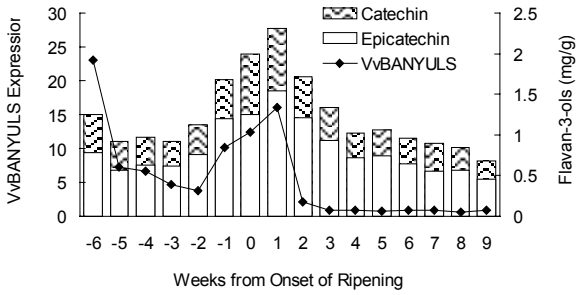


Figure 1. Flavan-3-ol accumulation (mg/g) and *VvBANYULS* expression in Shiraz grape seeds from fruit-set (-6 weeks) through ripening until commercial harvest (9 weeks). Flavan-3-ols separated into catechin and epicatechin derivatives.

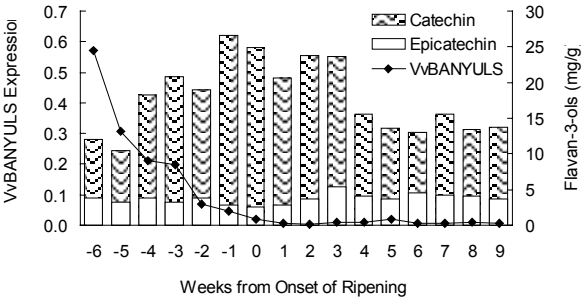


Figure 2. Flavan-3-ol accumulation (mg/g) and *VvBANYULS* expression in Shiraz grape skin.

Tannin accumulation in grape seeds commenced at fruit-set with the maximum observed around the onset of ripening (Fig. 1). In grape skin, tannin accumulation occurred from fruit set until 1-2 weeks after the onset of ripening (Fig. 2).

The pattern of *VvBANYULS* expression in the grape seed closely matched the accumulation pattern of flavan-3-ols based on epicatechin stereochemistry (Fig.1), consistent with the proposed model for epicatechin biosynthesis. In the skin, *VvBANYULS* expression was highest at fruit-set (Fig. 2) after which expression declined. Epicatechin is the minor flavan-3-ol component in the skin and is synthesised before fruit-set. Thus, decreasing *VvBANYULS* expression is consistent with epicatechin synthesis in skin occurring early in berry development.

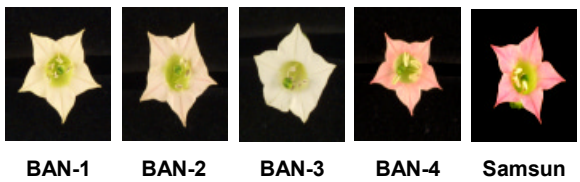


Figure 3. Flowers of *Nicotiana tabacum* var. Samsun transformed with *VvBANYULS* (control at far right)

Analysis of independent transformants of *Nicotiana tabacum* flowers showed that plants expressing high levels of *VvBANYULS* in petals had lower levels of anthocyanins (Fig. 3) and higher levels of tannin than wild-type flowers. This confirms a role for *VvBANYULS* in diverting anthocyanidin substrate away from anthocyanin production towards the synthesis of flavan-3-ols. What remains to be seen is whether the pattern of *LAR* expression is consistent with that of catechin accumulation in grapevines. Furthermore, while the proposed models might account for flavan-3-ol accumulation, the nature of tannin polymer formation has yet to be determined.

References

Abrahams, S., Lee, E., Walker, A. Tanner, G., Larkin, P. & Ashton, A. 2003. The *Arabidopsis* TDS4 gene encodes leucoanthocyanidin dioxygenase (LDOX) and is essential for proanthocyanidin synthesis and vacuole development. Plant J. **35**, 624-636.

Albert, S., Delseny, M. & Devic, M. 1997. BANYULS, a novel negative regulator of flavonoid biosynthesis in the Arabidopsis seed coat. Plant J. **11**, 289-299.

Devic, M., Guilleminot, J., Debeaujon, I., Bechtold, N., Bensuade, E., Koorneef, M., Pelletier, G. and Delseny, M. 1999. The BANYULS gene encodes a DFR-like protein and is a marker of early seed coat development. Plant J. **19**, 387-398.

Downey, M., Harvey, J. & Robinson, S. 2003a. Analysis of tannins in seeds and skins of Shiraz grapes throughout berry development. Aust. J. Grape Wine Res. **9**, 15-27.

Downey, M., Harvey, J. & Robinson, S. 2003b. Synthesis of flavonols and expression of flavonol synthase genes in developing grape berries of Shiraz and Chardonnay (*Vitis vinifera* L.). Aust. J. Grape Wine Res. **9**, 110-121.

Glories, Y. 1988. Anthocyanins and tannins from wine: organoleptic properties. In: Plant Flavonoids in Biology and Medicine II: Biochemical, Cellular, and Medicinal Properties. (Alan R. Liss, Inc., New York) pp. 123-134.

Li, Y., Tanner, G. & Larkin, P. 1996. The DMACA-HCl protocol and the threshold proanthocyanidin content for bloat safety in forage legumes. J. Sci. Food Agric. **70**, 89-101.

Rice-Evans, C., Miller, N. & Paganga, G. 1997. Antioxidant properties of phenolic compounds. Trends Plant Sci. **2**, 152-159.

Stafford, H. 1990. Flavonoid Metabolism (CRC Press, Inc., Boca Raton, Florida).

Tanner, G., Francki, K., Abrahams, S., Watson, J., Larkin, P. & Ashton, A. 2003. Proanthocyanidin biosynthesis in plants. Purification of legume leucoanthocyanidin reductase and molecular cloning of its own cDNA. J. Biol. Chem. **278**, 31647-31656.

Xie, D., Sharma, S., Paiva, N., Ferreira, D. & Dixon, R. 2003. Role of anthocyanidin reductase, encoded by *BANYULS* in plant flavonoid biosynthesis. Science **299**, 396-399.

Flavonol Accumulation and Expression of a Gene Encoding Flavonol Synthase Demonstrates Light Sensitivity of Flavonol Biosynthesis in Grapevines

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Abstract

The pattern of flavonol accumulation in developing grape berries, as determined by HPLC, was compared to the pattern in dark-grown grapes, and in fruit subsequently exposed to light. Flavonol accumulation was observed to be light dependent in grape berries and light inducible in shaded fruit. The expression pattern of a gene encoding the enzyme responsible for flavonol synthesis, flavonol synthase (FLS), was consistent with the pattern of flavonol accumulation in normally exposed berries. FLS expression was greatly reduced in the shaded fruit and increased substantially when shaded tissues were exposed to light.

Introduction

Flavonols are a flavonoid component of grapes and are thought to act as UV protectants and free radical scavengers (Flint *et al.*, 1985; Markham *et al.*, 1998; Smith & Markham, 1998). In wine, flavonols are potential copigments contributing to the colour-stability of anthocyanins (Boulton, 2001). Furthermore, flavonols have antioxidant activity in human serum and represent a nutraceutical potential (Maxwell *et al.*, 1994). This study sought to examine accumulation of flavonols during berry development and to clone the gene encoding flavonol synthase (FLS). In addition, this research sought to identify environmental factors that affect flavonol synthesis to develop viticultural practices to manage grape and wine flavonols.

Materials and Methods

Shiraz grapes (*Vitis vinifera* L.) were sampled throughout berry development from flowering until harvest (17 weeks post-flowering). The flavonol content was determined by HPLC as described by Downey *et al.* (2003).

Genomic DNA and total RNA extraction as well as PCR conditions are described in Downey *et al.* (2003). First strand cDNA synthesis was performed using the 3'-RACE adapter primer and Superscript II™ (Invitrogen Life Technologies) using methods recommended by the supplier. A cDNA fragment encoding flavonol synthase (FLS) was obtained by PCR of cDNA prepared from Shiraz flowers. Degenerate primers were based on FLS sequences in the GENBANK database. A predicted band of approximately 800bp was obtained and cloned into the pGEM-T Easy vector from Promega™. A number of independent clones were sequenced, the most promising of which was sequenced in both directions and found to encode a 797bp fragment with high homology to FLS sequences in the database. This sequence was named pVvFLS1 (GenBank Accession No. AY257978). Gene expression was determined by real-time PCR analysis. Quantitative real-time PCR was performed on a Rotor-Gene 2000™ (Corbett Research). Primers homologous to the grapevine cDNAs encoding *VvFLS1* and *VvUbiquitin1* were designed using primer 3 (http://www-genome.wi.mit.edu/cgi-bin/primer/primer3_www.cgi). *VvFLS1* was quantified relative to *VvUbiquitin1* and presented as a ratio.

A shading treatment, comprising polypropylene boxes designed to exclude light while maximising airflow, was applied to bunches of grapes prior to flowering to determine the effect of light on flavonol accumulation. This light exclusion treatment did not alter temperature or relative humidity inside the boxes compared to elsewhere in the canopy. The accumulation of sugar, anthocyanins and tannins in the shaded fruit has been shown not to differ significantly from the control (Downey *et al.*, 2004).

Results and Discussion

Flavonols were present in the skin of ripening grapes but were not detected in seeds or flesh. Flavonols were also present in buds, tendrils, inflorescences, anthers and leaves. The predominant flavonols in Shiraz grapes were quercetin-3-glucosides, with trace amounts of kaempferol-3-glucosides detected in flowers but not in developing berries. The concentration of flavonols (mg/gram fresh weight) was high in flowers and decreased between flowering and berry set then remained relatively constant throughout berry development (Fig. 1a). The total amount of flavonols in berries (mg/berry) was low in early berry development, but increased during ripening (Fig. 1b).

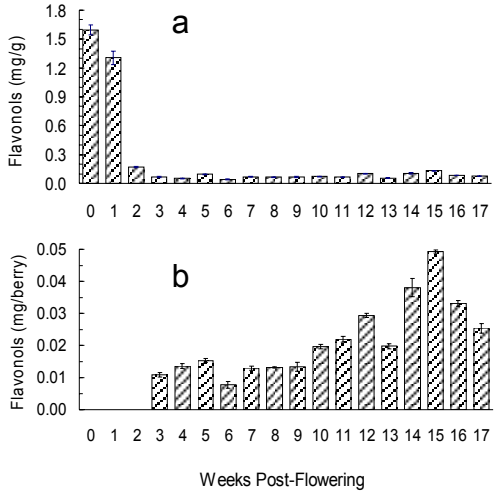


Figure 1. Flavonol accumulation in normally exposed grape berries expressed as (a) mg/g fresh weight of berry and (b) mg/berry (from Downey *et al.*, 2003).

A cDNA fragment was isolated with high homology to FLS genes from other plants. *VvFLS1* was expressed in leaves, tendrils, pedicels, buds and inflorescences as well as in developing grapes. Expression was highest between flowering and fruit set then declined, increasing again during ripening coincident with the increase in flavonols per berry. The results indicate that two distinct periods of flavonol synthesis occur in Shiraz grapes, the first around flowering and the second during ripening.

The shaded fruit had much lower levels of flavonols throughout berry development and at harvest the level of flavonols was less than 10% of that in exposed fruit. Expression of *VvFLS1* was greatly reduced in the shaded berries, shaded inflorescences and shaded leaves. Developing inflorescences and grapevine leaves were sampled three days after the shading treatment had been removed. In shaded leaves, the level of flavonols was less than 3% of that in the exposed leaves. After the shading treatment had been removed the level of flavonols in the leaf rose to around 39% that of normally exposed (control) leaves, or about 14-fold higher than the level in the shaded leaf. While the level of flavonols in the newly exposed leaves had not reached the level in exposed leaves, the level of *VvFLS1* transcript was more than 6-fold greater than the level in exposed leaves and 126-fold higher than in shaded leaves. The level of flavonols in the shaded inflorescence was only 20% of that in the exposed inflorescences, upon exposure of the previously shaded inflorescences the level of flavonols was around 45% of that in exposed inflorescence. The level of *VvFLS1* transcript was almost 2-fold higher than that of the control and 10-fold higher than the level observed in the shaded inflorescences. The

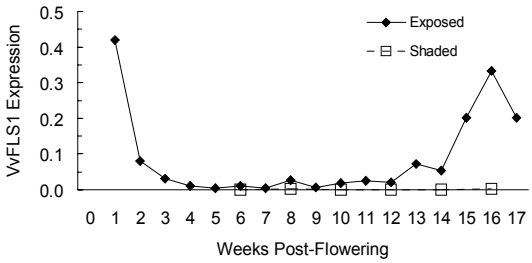


Figure 2. Expression of a gene encoding flavonols synthase (*VvFLS1*) in grape berries during development in both shaded and exposed fruit. Expression shown relative to *VvUbiquitin* (from Downey *et al.*, 2003).

pattern of *VvFLS1* expression in both shaded and exposed fruit is presented in Figure 2.

The results indicate that light exclusion significantly decreased flavonol synthesis and that flavonol biosynthesis in grapevines is induced by exposure to light. Thus, management practices that increase the sun-exposure of the fruit are likely to increase the flavonol content of both the fruit and final wine.

References

Boulton, R. 2001. The copigmentation of anthocyanins and its role in the colour of red wine: A critical review. Am. J. Enol.Vitic. **52**, 67-87.

Downey, M., Harvey, J. & Robinson, S. 2004. The Effect of Bunch Shading on Berry Development and Flavonoid Accumulation in Shiraz Grapes. Aust. J. Grape Wine Res. **10**, 55-73.

Downey, M., Harvey, J. & Robinson, S. 2003. Synthesis of flavonols and expression of flavonol synthase genes in developing grape berries of Shiraz and Chardonnay (*Vitis vinifera* L.). Aust. J. Grape Wine Res. **9**, 110-121.

Flint, S., Jordan, P. & Caldwell, M. 1985. Plant protective response to enhanced UV-B radiation under field conditions: Leaf optical properties and photosynthesis. Photochem. Photobiol. **41**, 95-99.

Markham, K., Tanner, G., Caasi-Lit, M., Whitecross, M., Nayudu, M. & Mitchell, K. 1998. Possible protective role for 3',4'-dihydroxyflavones induced by enhanced UV-B in a UV-tolerant rice cultivar. Phytochem. **49**, 1913-1919.

Maxwell, S., Cruikshank, A. & Thorpe, G. 1994. Red wine antioxidant activity in serum. Lancet **344**, 193-194.

Smith, G. & Markham, K. 1998. Tautomerism of flavonol glucosides: relevance to plant UV protection and flower colour. J. Photochem. Photobiol. A: Chem. **118**, 99- 105.

Appendix 2.

Program of Plenary Speakers and Oral presentations – XXII International Conference on Polyphenols, Helsinki 2004

XXII International Conference on Polyphenols



UNIVERSITY OF HELSINKI

25-28 August 2004
Helsinki, Finland

groupe polyphénols

Conference Programme

TUESDAY 24.8.

15.00-17.10 YOUNG RESEARCHERS' FORUM (Auditorium XII)
14.00-18.00 REGISTRATION

WEDNESDAY 25.8

8.30-10.00 REGISTRATION
10.00-10.55 OPENING CEREMONY
AWARDS
Kristiina Wähälä, Joseph Vercauteren, Marina Heinonen, Kurt Fagerstedt, Christian Jay-Allemand

Session 1 *Chairpersons M. Heinonen, Finland / J. Vercauteren, France*

10.55-11.40 PLENARY TOPIC 1 *Herman Adlercreutz, Finland*
Overview of phytoestrogens. (Polyphenols Communications 2004 page 1)

11.40-11.55 T1 *Kazumi Yagasaki, Japan*
Inhibitory effects of soybean isoflavones on the proliferation and invasion of hepatoma cells in culture. (p. 25)

11.55-12.10 T1 *Uriel Bachrach, Israel*
The specific anti-cancer activity of green tea polyphenols (p.27)

12.10-12.25 T1 *Louise Mennen, France*
Urinary polyphenols and their metabolites in spot urine samples as biomarkers of polyphenol intake. (p. 29)

12.25-12.35 DISCUSSION
12.35-14.00 LUNCH

Session 2 *Chairpersons D. Gang, USA / A. Hatakka, Finland*

14.00-14.40 PLENARY TOPIC 3 *Danièle Werck, France*
The 3-hydroxylation of phenolic esters and amides: the missing link in the phenylpropanoid pathway. (p. 3)

14.40-14.55 T3 *Stefan Martens, Germany*
Biochemical properties of dioxygenases involved in flavonoid biosynthesis in parsley: an evolutionary aspect. (p. 31)

14.55-15.10 T3 *Fumio Hashimoto, Japan*
Delphinograndins A and B, the New Anthocyanins from Delphinium L. Flowers and Mode of Inheritance of Flower Colors. (p. 33)

15.10-15.25 T4 *Poul Erik Hansen, Denmark*
Structural studies of a series of acetylated polyphenols and Schiff bases thereof all with intramolecular hydrogen bonds using deuterium isotope effects on ^{13}C NMR chemical shifts, PCA methods, X-ray and ab initio calculations. (p. 37)

15.25-15.35 DISCUSSION
15.35-15.55 COFFEE BREAK

15.55-17.00 POSTER SESSION I TOPICS 3,4, and 5

16.45-17.45 GROUPE POLYPHENOLS GENERAL ASSEMBLY
(The Great Hall)

18.00-19.30 HELSINKI CITY RECEPTION

THURSDAY 26.8

Session 3	*Chairpersons J. Lampe, USA / M. McNiven, Canada*
9.00-9.40	PLENARY TOPIC 2 *Mike Theodorou, UK* **Polyphenols and their influence on gut function and health in ruminants. (p. 5)**
9.40-9.55	T2 *Cyril Auger, France* **Flavanols (catechins monomers, procyanidins dimers and trimers) absorption, metabolism and excretion in a rat model system following the ingestion of a grape seed extract. (p. 41)**
9.55-10.10	T2 *Mariko Uehara, Japan* **Equol, a metabolite of daidzein, prevents bone loss in ovariectomized mice. (p. 43)**
10.10-10.25	T1 *Heide S. Cross, Austria* **Phytoestrogens regulate proliferation and vitamin D hydroxylase expression in the mouse colon – a model for human colon cancer prevention. (p. 45)**
10.25-10.35	DISCUSSION
10.35-11.00	COFFEE BREAK
Session 4	*Chairpersons J.-C. Merlin, France / T. Kondo, Japan*
11.00-11.40	PLENARY TOPIC 4 *Emmanuel Mikros, Greece* **The estrogen receptor and polyphenols: molecular simulation studies of their interaction. (p. 7)**
11.40-11.55	T2 *Warren N. Ratna, USA* **Dietary polyphenols influence gene expression by estrogen mimicry. (p. 47)**
11.55-12.10	T1 *Ralf Stohwasser, Germany* **Structure-function relations of proteasome inhibition by polyphenols. (p. 49)**

12.10-12.25 T1 *Stéphanie V.E. Prigent, The Netherlands*
Covalent interactions between chlorogenic acid and proteins or protected amino acids, and their effects on protein functional properties. (p. 51)

12.25-12.35 DISCUSSION
12.25-14.00 LUNCH

Session 5 *Chairpersons K. Fagerstedt, Finland / T. Katayama, Japan*

14.00-14.40 PLENARY TOPIC 3 *Vincent L. Chiang, USA*
Monolignol Biosynthesis and Genetic Engineering of Lignin in Trees. (p. 9)

14.40-14.55 T3 *Benoit Van der Rest, France*
Soluble phenolic accumulation as side effect of lignin downregulation. (p. 53)

14.55-15.10 T3 *Jussi Sipilä, Finland*
On the role of dibenzodioxocines in lignin biosynthesis. (p. 55)

15.10-15.20 DISCUSSION
15.20-15.40 COFFEE BREAK

Session 6 *Chairpersons I. El Hadrami, Morocco / O. Andersen, Norway*

15.40-15.55 T4 *Stefan M. Willför, Finland*
Knotwood in trees - a new rich source of bioactive flavonoids. (p. 57)

15.55-16.10 T5 *Mark O. Downey, Australia*
Flavonol accumulation and expression of a gene encoding flavonol synthase demonstrates light sensitivity of flavonol biosynthesis in grapevines. (p. 59)

16.10-16.25 T4 *Stéphane Quideau, France*
DNA topoisomerase inhibitors acutissimins and other hybrid polyphenols in red wine – reactivity, synthesis and biological evaluation. (p. 61)

16.25-16.40 T5 *Heidi Halbwirth, Austria*
Influence of polyphenols on fire blight resistance in apple. (p. 63)

16.40-16.50 DISCUSSION

16.50-18.00 POSTER SESSION II TOPICS 1,2, and 6

18.00-19.30 RECEPTION HOSTED BY THE RECTOR OF THE UNIVERSITY OF HELSINKI

FRIDAY 27.8

Session 7 *Chairpersons Kanae Yamashita, Japan / H. Cross, Austria*

9.00-9.40 PLENARY TOPIC 6 *Young-Joon Surh, South Korea*
Chemopreventive Effects of Antioxidative and Antiinflammatory Phytonutrients on Skin Carcinogenesis. (p. 11)

9.40-9.55 T6 *Jacob Vaya, Israel*
Chalcones as potent tyrosinase inhibitors. Catechol vs. resorcinol substructure – a structure/activity relationship study. (p. 65)

9.55-10.10 T4 *Sampo Karkola, Finland*
Molecular modeling of aromatase for studying the binding of phytoestrogens. (p. 67)

10.10-10.25 T4 *Samir Yahiaoui, France*
Pharmacomodulation of Flavonoids as new aromatase inhibitors. (p. 69)

10.25-10.35 DISCUSSION

10.35-11.00 COFFEE BREAK

Session 8 *Chairpersons: C. Lister, New Zealand/ C. Santos-Buelga, Spain*

11.00-11.40 PLENARY TOPIC 4 *Victor de Freitas, Portugal*
Chemical Transformations of Anthocyanins Yielding a Variety of Colours. (p. 13)

11.40-11.55 T4 *Maarit J. Rein, Finland*
Anthocyanin copigmentation reactions with phenolic acids. (p. 71)

11.55-12.10 T4 *Paul-Henry Ducrot, France*
New methodologies for the Synthesis of Proanthocyanidins. (p. 73)

12.10-12.25 T1 *Joanne M. Holden, USA*
Development of a database for proanthocyanidins in food. (p. 75)

12.25-12.35 DISCUSSION
12.35-14.00 LUNCH

Session 9 *Chairpersons C. Gallet, France / K. Pihlaja, Finland*

14.00-14.40 PLENARY TOPIC 5 *Liliana Gianfreda, Italy*
Treatment of phenol polluted systems by biotic and antibiotic catalysts. (p. 15)

14.40-14.55 T5 *Abdelbasset El Hadrami, Canada*
Fertirrigation with olive-oil mill wastewaters in Mediterranean areas: effects of the phenolics fraction of the by-product on the growth and development of some crops. (p. 77)

14.55-15.10	T5 *Wolf F. Brandt, South Africa* **The predominant polyphenol in the leaves of the resurrection plant Myrothamnus flabellifolius, 3,4,5-tri-O-galloylquinic acid, protects membranes against desiccation and free radical induced oxidation. (p. 79)**
15.10-15.20	DISCUSSION
15.20-15.40	COFFEE BREAK
Session 10	*Chairpersons C. Jay-Allemand, France / V. Lattanzio, Italy*
15.40-16.20	PLENARY TOPIC 5 *Dieter Treutter, Germany* **Significance of flavonoids in plant recistance – an update. (p. 17) -*Groupe Polyphénols Award* -**
16.20-16.35	T5 *C. Edgardo Filippone, Italy* **Over-expression of a fungal laccase gene in tobacco for phytoremediation of PAHs contaminated soils. (p. 81)**
16.35-16.50	T4 *Kumi Yoshida, Japan* **UV-B resistant polyacylated anthocyanins in blue flower petals and their screening effect of protecting DNA. (p. 83)**
16.50-17.05	T4 *Claudia Kinitz, Germany* **Analysis of Polyphenols: Benefits of Method-Optimization. (p. 85)**
17.05-17.20	T5 *James E. Cooper, Northern Ireland, UK* **Dominant role of flavonoids among signal molecules involved in the formation of legume-rhizobia symbioses. (p. 87)**
17.20-17.30	DISCUSSION
19.30-24.00	BANQUET

SATURDAY 28.8

Session 11 *Chairpersons V. Cheynier, France / P. Knuthsen, Denmark*

9.00-9.40 PLENARY TOPIC 2 *Irene Mueller-Harvey, UK*
Tannins in animal nutrition and health. (p. 19)

9.40-9.55 ICP 2006

9.55-10.10 T1 *Bruce P. Burnett , USA*
A combination free-B-ring flavonoid and flavan, anti-inflammatory plant extract increases memory and speed of processing in animal and human clinical models. (p. 89)

10.10-10.25 T4 *Kirsti Parikka, Finland*
Deuteration of polyphenols for analytical and metabolic studies. (p. 39)

10.25-10.35 DISCUSSION
10.35-11.00 COFFEE BREAK

Session 12 *Chairpersons N. About, France / R. Hiltunen, Finland*

11.00-11.40 PLENARY TOPIC 6 *Patrice André, France*
Polyphenols and cosmetology: biological interest, phytochemical aspects and technical approach. (p. 21)

11.40-11.55 T6 *Alena Svobodová, Czech Republic*
Effects of polyphenols from Silybum marianum on UVA-induced apoptosis and DNA damage in human skin cells. (p. 91)

11.55-12.10 T1 *Shibo Jiang, USA*
Polyphenols in teas inhibit HIV-1 inhibition by blocking virus entry. (p. 93)

12.10-12.25 T4 *Patrick Trouillas, France*
A Theoretical Study of Reactivity of OH groups in Quercetin and Taxifolin: Specificity of the 3-OH group. (p. 103)

12.15-12.35	DISCUSSION
12.35-14.00	LUNCH
Session 13	*Chairpersons P. Lehtonen, Finland / M. Tahiri, France*
14.00-14.40	PLENARY TOPIC 1 *Sabine Kulling, Germany* **Bioavailability and metabolism of pure cyanidin-3-O-glucoside in humans. (p. 23)**
14.40-14.55	T1 *Johanna W. Lampe, USA* **Factors influencing metabolism of the soy isoflavone daidzein. (p. 95)**
14.55-15.10	T1 *Olivier Dangles, France* **Inhibition of the metmyoglobin–induced peroxidation of linoleic acid by polyphenols and other dietary antioxidants: a pertinent model for assessing the antioxidant activity in the gastro-intestinal tract. (p. 97)**
15.10-15.25	T1 *Francesco Branca, Italy* **A thematic network for phytoestrogen research in Europe. (p. 99)**
15.25-15.40	T1 *Jaakko J. Mursu, Finland* **The short-term effects of phenolic compounds on postprandial dyslipidemia and lipid peroxidation in healthy men; a clinical trial. (p. 101)**
15.40-15.50	DISCUSSION
15.50-16.00	CLOSING OF THE CONFERENCE

General information

Registration and information

The Registration and Information Desk is located on the 1st floor of the University Main Building. Participants can access the desk area from Aleksanterinkatu or Unioninkatu (The Senate Square). The desk is open on Tuesday 24th from 14.00 - 18.00, on Wednesday 25th from 8.30 – 10.00 and during the scientific programme every day during the conference.

Posters

There are four halls reserved for posters. Poster Area I is the Main Entrance Hall from Fabianinkatu, Poster Area II, III and IV are on the 2nd floor and Poster Area V is on the 3rd floor of the University Main Building. People presenting posters are advised to put up their posters directly after the registration. Poster numbers and presenters can be found from the *Polyphenols Communications 2004*. All the posters are accessible during the conference.

Speakers

Speakers are advised to check and leave their presentations in advance in Auditorium II on the 2nd floor.

Groupe Polyphénols Secretariat

Locates in Auditorium II, second floor. Open daily during the breaks.

Computers

On the second floor in Auditorium III there are computers with internet connection for public use. Cell phones should be switched off while in the computer classroom.

Lunch and coffee

Lunch and coffee are served on the 2nd floor at both sides of the main entrance of The Great Hall. In the teachers' lounge there are few seats available for those who need to rest their feet.

Please Note

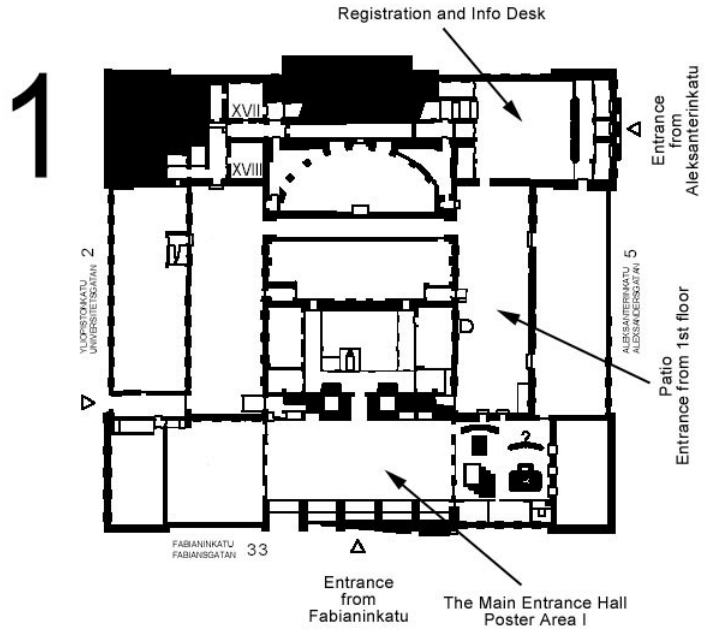
Keep your badges with you at all times.
In the Great Hall, eating and drinking are strictly prohibited and cell phones must be switched off.

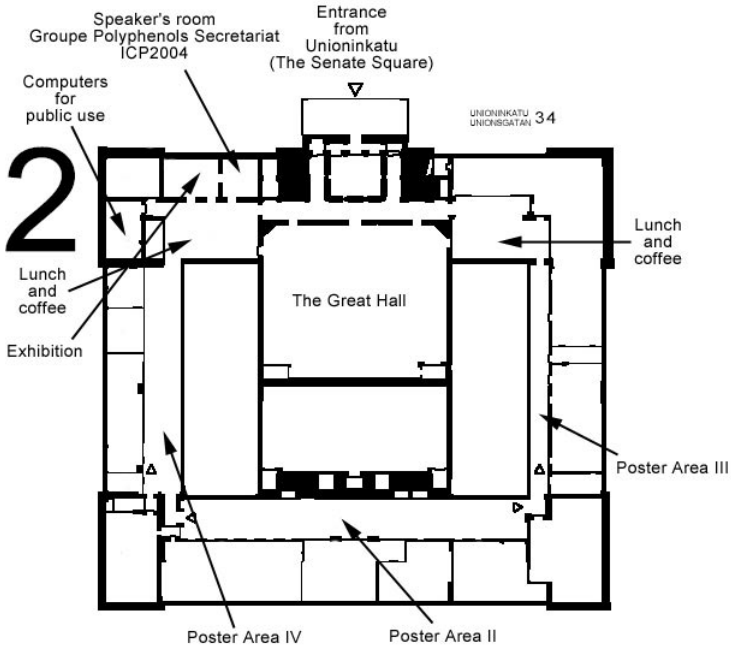
People wishing to smoke are directed to the patio, which is accessible from the Registration Desk. Smoking is not allowed indoors nor at the main entrances.

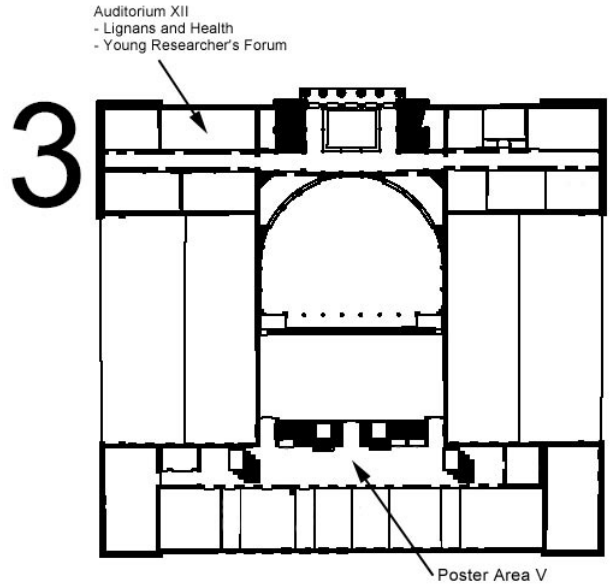
Information about Helsinki
Helsinki Help (tourist guides) are available at the Registration Desk to assist participants and accompanying persons with questions concerning Helsinki Area: Tuesday 24th 14.00-18.00, Wednesday 25th 8.30-11.00 and Thursday 26th 10.15-11.15, 12.35-14.15 and 15.15-15.45.

Helsinki Festival
Information and programme available at the Helsinki Helpers desk. Thursday 26th August 2004 “The Night of the Arts”: street entertainment, concerts, art exhibitions etc.

Accommodation, posttours
Preordered posttour vouchers can be collected from *Congreszon* representative at the registration desk. Enquiries regarding posttours and accommodation should be addressed to *Congreszon.*




2
Speaker's room
Groupe Polyphenols Secretariat
ICP2004
Entrance
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(The Senate Square)
Computers
for
public use
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UNIONSGATAN
Lunch
and
coffee
Lunch
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coffee
The Great Hall
Exhibition
Poster Area III
Poster Area IV
Poster Area II


Auditorium XII
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- Young Researcher's Forum
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Timetable of the Conference

	tue 24th		wed 25th	thu 26th	fri 27th	sat 28th
8.30-9.00			Registration			
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