

58

FIFTYEIGHTH
ANNUAL MEETING

SCIENCE

a platform for PROGRESS



58th
Annual
Meeting

June 19–22, 2007

**Grand Sierra Resort
Reno, Nevada USA**

TECHNICAL ABSTRACTS



AMERICAN SOCIETY FOR ENOLOGY AND VITICULTURE

**Thank You
2007 Best Student Presentation
Award Sponsors**

Enology

**Lallemand
Petaluma, CA**

Viticulture

**Sunridge Nurseries
Bakersfield, CA**

**Thank you for your
continued support**



2007 Program Committee

Craig Rous (Chair), Bear Creek Winery

Larry Bettiga, University of California, Cooperative Extension

Linda Bisson, University of California, Davis

John Clark, The Wine Group

Tom Collins, LangeTwins Winery

James Kennedy, Oregon State University

Steve Kupina, Constellation Wines US

Susan Rodriguez, California State University, Fresno

Patty Saldivar, Hall Wines

Chris Smith, Bogle Winery

Mike Vail, Agro Tech

Paul Verdegaal, University of California, Cooperative Extension

Copyright © 2007. The American Society for Enology and Viticulture (ASEV) is not responsible for incorrect listings or errors in the abstracts. The ASEV Annual Meeting and related documents and graphics are the property of the ASEV. Reproduction of any part of the ASEV Annual Meeting in any form without written consent is strictly prohibited. Permission requests may be submitted to www.copyright.com or contact the Copyright Clearance Center, Inc. (CCC), 222 Rosewood Drive, Danvers, MA 01923 (978-750-8400). All presentations of any form are exclusive and released only to the ASEV and its recording contractor for reproduction in any form including electronic/Internet distribution.

The ASEV is not responsible for statements or opinions printed in its publications; they represent the views of the authors or the persons to whom they are credited and are not binding on the ASEV as a whole. Any participant presenting any material for which copyright laws apply is solely responsible for adhering to such laws. The mention of products or services in the ASEV 58th Annual Meeting Technical Abstracts does not imply endorsement of these or other products.



American Society for Enology and Viticulture
PO Box 1855
Davis, CA 95617-1855 USA
Tel: 530 753-3142 Fax: 530 753-3318
Email: society@asev.org Website: www.asev.org

Alphabetical Listing of Presenting Authors

Anderson, M.	19	Nicholas Cahill, K.	12
Athamneh, A.	22	Noba, S.	2
Baumgartel, J.	11	Podmaniczky, P.	16
Benkwitz, F.	1	Qian, M.	20
Berna, A.	1, 22	Ramming, D.	14
Block, D.	11	Robinson, S.	5
Briceño, E.	3	Ross, C.	6
Brock, P.	8	Rubin, J.	15
Conterno, L.	4	Runnebaum, R.	24
Cortell, J.	28	Sanborn, M.	7
Cousins, P.	12	Scholz, R.	30
Dever, A.	3	Schreiner, R.	15
Elias, R.	28	Shepherd, H.	17
Fitzpatrick, T.	29	Skibsted Jensen, J.	10
Fuster, A.	9	Skinkis, P.	20
Galvan, T.	23	Skogerson, K.	24
Gethner, J.	17	Smith, B.	25
Harbertson, J.	9	Sorokowsky, D.	19
Hills, L.	17	Tarczal, E.	14
Krasnow, M.	26	Trela, B.	8
Lambert, J.J.	13	Tsay, M.J.	7
Languet, P.	18	Umiker, N.	23
Marin, A.	4	Úrbez-Torres, J.	25
Marquez, A.	13	Waterhouse, A.	8
Mendez, M.	21	Wilker, K.	29
Mills, D.	5	Wolpert, J.	26
Mirzoian, A.	2		

Abstracts here are those submitted and accepted through the 2007 Call for Papers only.

Sessions & Presentations Listing

Wednesday, June 20 and Thursday, June 21

Enology Poster Session	1 - 10
Viticulture Poster Session	11 - 16
Industrial Poster Session	17 - 18

Wednesday, June 20

Viticultural Practices Session	19 - 21
Grape & Wine Composition and Sensory Analysis Session	22 - 24

Thursday, June 21

Vine Pest Management Session	25 - 27
Phenolics Session	28 - 30

Abstracts are in the approximate order as noted in the conference program. Abstracts here are those submitted and accepted through the 2007 Call for Papers only.

Identification and Quantification of Aroma Compounds in Sauvignon blanc Wines

Frank Benkwitz, Laura Nicolau,* and Takatoshi Tominaga

Department of Chemistry, University of Auckland, New Zealand

[l.nicolau@auckland.ac.nz]

Sauvignon blanc currently accounts for over 50% of New Zealand wine production and over 70% of wine exports, making it the most important commercial grape variety for the New Zealand wine industry. Our goal was to identify and quantify volatile compounds (aroma) in Sauvignon blanc wine, with a particular focus on the Marlborough region. Through the use of gas chromatography, our research has shown that 3-mercaptohexanol and 3-mercaptohexylacetate are typically present in significantly higher concentrations in wines from New Zealand, especially from the Marlborough region, compared with wines from Australia, United States, France, and South Africa. Some C6 alcohols (green, grassy aromas) and some fermentative esters (fruity aromas) have higher concentrations in New Zealand wines. The quantification of several terpenes showed that these compounds do not significantly contribute to the aroma of Sauvignon blanc, considering their concentration and threshold levels. Using gas chromatography-olfactometry, we identified compounds that have not previously been taken into account for Sauvignon blanc aroma. Two compounds with a fruity and a flowery smell, respectively, were also found, although their structure remains as yet unknown.

Comparison of the Static and Dynamic Signals from an Electronic Nose as Predictors of Berry Ripeness

David Clifford,* Glenn Stone, Amalia Z. Berna, Stephen Trowell, and David Lovell

CSIRO Food Futures Flagship, North Ryde, NSW 1670 Australia [David.Clifford@csiro.au]

Time to ripeness of grapes is an important property, and reliable predictors would be desirable. The Alpha MOS electronic nose (e-nose) aims to measure volatiles objectively using an array of sensors whose electrical properties change. Potentially these changes may be used to predict time to ripeness. The standard data analysis with an e-nose uses the relative change in resistance of each of the sensors (the static signal). However, the dynamic signal recorded for each sensor over time may contain information that can be used for classifying samples. Examples of such information include the time taken to reach peak, the time to return to baseline, the shape of the peak, and the slope of the signal on either side of the peak. Development of the e-nose as an alternative to GC-MS or sensory panels in enology through the use of the entire dynamic signal may prove fruitful. Exponential decay functions are combined into an empirical model for the dynamic signal. Having fitted the empirical model, the signal can be summarized in many ways. The model parameter estimates can be used directly for classifier building and subsequent prediction of new samples. Illustration is provided by predicting the time to ripen for Cabernet Sauvignon grapes based on juice and slurry samples. The performance of the methods is compared to use of static signals only.

Chemical Identification of Ancient Egyptian Herbal Wines

Armen Mirzoian,* Gretchen R. Hall, and Patrick E. McGovern

Alcohol and Tobacco Tax and Trade Bureau, Beltsville, MD 20705

[armen.mirzoian@ttb.gov]

Dating to ca. 3150 BC, a collection of 700 jars deposited in Abydos (Egypt) in the tomb of Scorpion I, one of the first pharaohs of Egypt, is extremely important for the earliest history of domesticated *Vitis vinifera* and winemaking in the Middle East. A previous study has shown that the resinated wine inside these jars was made and exported from the Jordan Valley and environs, 600 km away. Solid-phase microextraction gas chromatography-mass spectrometry and tandem liquid chromatography mass spectrometry have confirmed these findings for tartaric acid (a marker compound for grape/wine) and a tree resin additive (diterpenes). The identification of other volatile and semivolatile components points to the addition of mint (genus *Mentha*). A number of compounds identified in a later-inscribed Byzantine wine jar from Gebel Adda (Egypt) are indicative of rosemary (genus *Rosminthus*) and tree resin additives. Both mint and rosemary became significant culinary and medicinal herbs in the region. Their administration via wine can now be traced back thousands of years.

Determination of Ochratoxin A in Wine by Immunoaffinity Cleanup and Liquid Chromatography Tandem Mass Spectrometry

Shigekuni Noba,* Masayuki Omote, Yasushi Kitagawa, and Naoki Mochizuki

Asahi Breweries, Ltd., Midori 1-1-21, Moriya City, Ibaraki prefecture, Japan

[shigekuni.noba@asahibeer.co.jp]

Ochratoxin A is a widely distributed mycotoxin produced mainly by *Aspergillus ochraceus* and *Penicillium verrucosum*. Ochratoxin A is nephrotoxic, and carcinogenic in both humans and animals, and the International Agency for Research on Cancer classified ochratoxin A in Group 2B (possibly carcinogenic to humans). A provisional tolerable weekly intake level of 100 ng/kg of body weight has been established by the Joint FAO/WHO Expert Committee on Food Additives. Ochratoxin A is found in various foods and beverages including cereals, beans, dried fruits, coffee, beer, and wine. Several countries have their own regulations for ochratoxin A content in several food commodities; for example, the maximum levels established by the European Union are 2.0 µg/L for wine. We attempted to develop a simple and sensitive method for investigating ochratoxin A in wine using liquid chromatography tandem mass spectrometry. We were able to determine ochratoxin A in wine with a simple pretreatment process that includes immunoaffinity column purification. We have established an analysis method for ochratoxin A with high sensitivity, and the detection limit was 0.0003 µg/L (based on a signal/noise ratio of 3:1) in wine. Analysis of 74 samples of domestic and imported wines showed ochratoxin A levels ranging from <0.0003 to 0.82 µg/L, with an incidence of contamination of 92.1% for red wines and 77.8% for white wines. All samples analyzed complied with EU regulations.

Effect of Cladosporium Rot on Wine Quality

Erika X. Briceño, Bernardo A. Latorre,* Edmundo Bordeu, and
Philippo Pszczółkowski

Facultad de Agronomía e Ingeniería Forestal, Pontificia Universidad Católica de Chile,
Santiago, Chile [blatorre@uc.cl]

Cladosporium rot (*Cladosporium herbarum* and *C. cladosporioides*) frequently occurs in delayed harvests, mainly in Cabernet Sauvignon grapes (*Vitis vinifera*) in Chile. The effect of Cladosporium rot on wine quality was studied. Wine made with 12 to 15 kg of infected grapes (incidence >50%) was compared with wine equally made but using apparently healthy grapes of Cabernet Sauvignon, Carménère, and Chardonnay. Grapes were harvested from commercial vineyards at maturity (total soluble solids >22%). Wines were analyzed and subjected to sensory evaluation. Analyses of aromatic compounds by gas chromatography were also performed. Cabernet Sauvignon and Carménère wines made with infected grapes were significantly different ($p < 0.05$) from wine made with apparently healthy grapes in residual sugars, anthocyanins, hue values, and tannins. Chardonnay wines were significantly different only in residual sugars. Sensory analysis by paired-comparison test ($p < 0.05$) differentiated negatively the aroma from all wines produced with grapes with Cladosporium rot. In Cabernet Sauvignon and Chardonnay wines, color was negatively affected and alcohol increased. Astringency was consistently higher in red wines made with Cladosporium rot. The chromatographic profile of aromas of Cabernet Sauvignon wines made with grapes with Cladosporium rot differed significantly in several compounds from wine profiles obtained for wine made with apparently healthy grapes. Results showed that Cladosporium rot reduced wine quality of white and red wines, reducing color, aroma, and flavor. To obtain wines of high quality, it will be necessary to adopt vineyard management strategies that prevent the development of this disease.

Sensory Properties and Laccase Activities of Wines Made from Botrytis-rotted, Laccase-Spiked, and Untreated Grapes

Ashley Dever, Novella Nelson, Katie Santora, and Hildegard Heymann*

Department of Viticulture and Enology, University of California, Davis 95616
[hheymann@ucdavis.edu]

The relationship between the sensory properties of wine made from untreated grapes, grapes mixed with rotted berries (10%), and grapes spiked with commercial laccase was studied. The levels of *Botrytis* in all three treatments were monitored daily with *Botrytis*-specific lateral flow immuno-devices and the levels of laccase by an enzyme assay. *Botrytis* levels remained high throughout fermentation in juice and wine from grapes with added rotted berries. No *Botrytis* was found in juice from the control or laccase-spiked grapes. Laccase levels were initially high, but dropped dramatically during fermentation as did the low levels of laccase found in juice from grapes with fungal-rotted berries. Preliminary sensory analysis indicated that there was a significant difference between the control wine and that from rotted grapes. Further descriptive analysis revealed significant aromatic differences in the wines from the rot treatment and the control

and laccase-spiked grapes. These differences were related to the perception of vegetal, ocean, and earthy aromas. The laccase treatment varied significantly from the control and rot treatment in light fruit aroma.

Effects of Wine Bottle Closure Type on Consumer Purchase Intent and Price Expectation

Anna B. Marin* and Catherine A. Durham

Food Innovation Center, Oregon State University, Portland, OR 97209

[anna.marin@oregonstate.edu]

The effect of natural cork, synthetic cork, and screwcap closures on the purchase intent and price expectation of wine consumers was examined for two commercial wines, a Chardonnay and a Merlot. Consumer purchase behavior was measured in a taste survey where participants tasted and rated the wines twice: once when the closure information was not known and a second time when the closure information was revealed. Causal effects were evaluated for impact on purchase behavior when the closure information was revealed using ordinary least squares regression, logistic regression models, and path analysis. Liking rating for the wine was the most important variable to impact purchase intent. The effect of liking on purchase intent was positive where there was an ~10% higher probability of buying the wine for a one-unit increase in liking rating; type of closure had only limited impact on purchase intent. The results for price expectation are different from purchase intent in that liking does not impact expected price; quality has the greatest impact. For the expected price models, results indicate that consumers expected to pay significantly less for a bottle with a screwcap for both wines. The significant negative effect of the screwcap on expected price relative to synthetic and natural corks indicates a direct negative effect. However, the positive correlation of natural cork and negative correlation of screwcap with quality rating indicates that closure type also impacts expected price indirectly through consumer perception of quality.

Influence of Sugar and Nitrogen Sources on Growth and Phenolic Off-Flavor Production by *Brettanomyces bruxellensis* Isolated from Wine

Lorenza Conterno,* Gosia Lasik, Elizabeth Tomasino, Katharina

Schneider, Frank Hesford, and Thomas Henick-Kling

Department of Food Science and Technology, New York State Agricultural Experiment Station, Cornell University, Geneva, NY 14456 [lc98@cornell.edu]

The growth and the off-flavor production of the wine spoilage yeast *Brettanomyces bruxellensis* were investigated. We analyzed growth and the three dominant off-flavor compounds in model wine media in presence of various sources of nitrogen, various amounts of organic nitrogen, and residual sugars. Five strains of *B. bruxellensis* isolated from wine were tested. Growth diminished in the absence of amino acids, but, importantly, *B. bruxellensis* grew with 0.5 g/L diammonium phosphate and no amino acids. All strains grew with as little as 50 mg/L total amino acids added to the medium. Various amounts of nitrogen did affect ethyl phenols production, yet the production of ethyl phenols seems to be more strain dependent. More ethyl phenols were produced when only di-

ammonium phosphate was present. When no pentoses or hexoses or only pentoses were present, yeast growth was limited and the total amount of ethyl phenols was lower. When only pentoses were present, production of 4-ethyl guaiacol was observed. This study shows that the environment for yeast growth, the wine, plays an important role in the potential development of phenolic off-flavors. Results also show that there are significant differences among different strains of *B. bruxellensis* in response to different nutrient conditions. The differences in ethyl phenols production among the strains were more greatly enhanced by the presence of a nitrogen source than by the amount of residual sugars.

Identification and Characterization of *Bacillus* Species Isolated from California Wines

C.M. Lucy Joseph,* Mike Ramsey, Paula Mara, and David Mills

Department of Viticulture and Enology, University of California, Davis, CA 95616
[cmjoseph@ucdavis.edu]

Most bacterial contaminants cannot survive in wine because of low pH, high acid, and high alcohol levels. It is assumed that *Bacillus* endospores will not germinate in wine because of the same constraints. There have been anecdotal reports of aerobic bacilli found in wines as well as some evidence that *Bacillus* species can be introduced into wines by corks or contaminated air and survive in the wines. However, there has been little published information on the isolation of bacilli from finished wines. We isolated several *Bacillus* species from wines made at UC Davis as well as from commercial wines. Two species, *B. sporothermodurans* and *B. megaterium*, were isolated from four separate California wines. The isolates were identified by ribosomal RNA gene sequencing and further characterized using API strips. Surprisingly, common methods to detect wine-related bacteria, such as real-time PCR or standard plating schemes, did not reveal these species. However, they did grow on media used to plate wine yeasts, such as yeast malt extract or Wallerstein Laboratory Medium. Given that bacilli form heat-resistance endospores, the implications for spoilage problems because of microbial instability are of concern, potentially impacting both wine flavor and visual sensory characteristics.

Identification of Genes Associated with Ester Formation and Degradation in Yeast Strain BY4742

Stuart Robinson and Linda Bisson*

Department of Viticulture and Enology, University of California, Davis, CA 95616
[lfbisson@ucdavis.edu]

The aim of this study was to identify genes associated with ester formation and degradation in the laboratory yeast strain BY4742. A preliminary experiment designed to determine the optimal time of ester production using SPME GC-MS found optimal ester occurring at three days using a medium with high arginine and ammonium phosphate supplementation. Seventy-five deletion mutant strains were chosen using the *Saccharomyces* Genome Database based on their functional homology to four genes (*IAH1*, *EHT1*, *ATF1*, *ATF2*) known to impact ester formation and degradation. The suspected ester synthase and esterase

genes are grouped into four main categories based on their functional homology: (1) hydrolase, (2) branched chain amino acid degradation, (3) fatty acid metabolism, and (4) lipid particle genes. The parent strain BY4742 produced the following 25 esters in descending order: ethyl caprate, ethyl caprylate, ethyl laurate, ethyl caproate, ethyl 9-decenoate, pentadecanoic acid, 3-methylbutyl ester, ethyl nonanoate, ethyl myristate, isoamyl caprylate, ethyl heptanoate, phenethyl acetate, isobutyl caprate, ethyl palmitate, ethyl 9-hexadecenoate, isoamyl acetate, butanoic acid, 3-methyl-, 2-phenylethyl ester, ethyl acetate, isoamyl laurate, 2-ethylhexyl acetate, benzenoacetic acid, 2-phenylethyl ester, dodecanoic acid, 2-phenylethyl ester butanoic acid, and ethyl ester. Initial analysis showed expected effects of deletion of the *ARO10* gene that is responsible for catabolism of phenylalanine. There is a clear reduction in the family of phenethyl esters. Loss of the branched chain amino acid gene, *BAT2*, showed a modest increase on fatty acid ester formation, an ester family unrelated to its biological activity.

Effect of Serving Temperature on Sensory Attributes of White and Red Wines

Carolyn F. Ross* and Karen Weller

Department of Food Science and Human Nutrition, Washington State University, Pullman, WA 99164 [cfross@wsu.edu]

The serving temperature of both red and white wines has been dictated by convention in that red wines are served around room temperature and white wines are served chilled. The objective of this study was to determine the impact of white wine serving temperature (4, 10, and 18°C) and red wine serving temperature (14, 18, and 23°C) on the sensory attributes of the wine using a trained panel. A sensory panel of 11 members (white wine) and 20 members (red wine) was trained to recognize the sensory attributes of aroma, sweetness, and acidity in white wine and astringency, bitterness, and aroma in red wine. Following training sessions, panelists evaluated a series of model wines served at different temperatures. The control red wine was adjusted to enhance bitterness and astringency, while the control white wine was adjusted to enhance sweetness and acidity. For both red and white wine, the adjusted control wine was rated as significantly different in the desired attribute compared with the control wine. Serving temperature had a significant impact on aroma perception in white wine ($p < 0.05$). Sweetness and acidity intensities were significantly influenced by the interaction between panelist and temperature interaction. Serving temperature of red wine did not have a significant effect on any of the sensory attributes examined. Results indicate that sensory attributes of white wines may be more influenced by serving temperature than red wines.

Impact of Fining on Sensory and Chemical Properties of Washington State Chardonnay and Gewürztraminer Wines

Melissa Sanborn, Carolyn F. Ross,* and James Harbertson

Department of Food Science and Human Nutrition, Washington State University, Pullman, WA 99164 [cfross@wsu.edu]

We evaluated the impact of fining on the sensory and chemical properties of Washington State white wine. Unfinned Chardonnay and Gewürztraminer wines were treated with bentonite (1000 mg/L), isinglass (60 mg/L), Sparkaloid (360 mg/L), activated charcoal (450 mg/L), whole milk (500 mg/L), and wheat gluten (400 mg/L) at 12.8°C and compared to a control (nontreated). The initial turbidity levels of the Chardonnay and Gewürztraminer wines were 211 and 27.8 NTU (nephelometric turbidity unit), respectively. Bentonite, isinglass, and Sparkaloid treatments successfully clarified both Chardonnay and Gewürztraminer wines within one week to <10 NTU. Activated charcoal, whole milk, and wheat gluten successfully clarified Chardonnay wine to <10 NTU within one week; turbidity levels <10 NTU were not achieved in Gewürztraminer with activated charcoal, whole milk, and wheat gluten. All wines were filtered with a 0.45-µm membrane filter, bottled, and stored at 4°C. For the Chardonnay wine, an expert panel found no significant differences in sweetness, aroma, and mouthfeel between treatments. The isinglass treatment produced a more intense fruity flavor than the other treatments. Bentonite resulted in a more intense yellow color, while wheat gluten and activated charcoal were lowest in color intensity. The wheat gluten imparted a bitter aftertaste in the wine. For the Gewürztraminer wine, no significant differences were found among treatments for color intensity, sweetness, acidity, mouthfeel, and aftertaste. The wheat gluten had the least intense flavor and aroma when compared with the other Gewürztraminer wine treatments. The wines are currently undergoing chemical analysis.

Sensory Drivers of Wine Quality: Pinot noir Case Study

Jean-Xavier Guinard* and Ming-Jen Tsay

Department of Food Science and Technology, University of California, Davis, CA 95616 [jxguinard@ucdavis.edu]

The definition of wine quality has been debated by various groups associated with wine, including wine critics, wine industry members (i.e., winemakers, vineyard managers, wine marketers), and wine consumers. We focused on defining the sensory drivers of wine quality, specifically in Pinot noir wines. A descriptive space was constructed and basic chemical analyses were run for a set of 20 Pinot noir wines. Overall quality ratings of these wines were collected from wine experts and the wine industry, while overall liking ratings of a subset of these wines were collected from wine consumers. In this way, two statistical methods were used to analyze how these datasets relate to one another, an external preference map of consumer preferences regressed onto the descriptive space, and a partial least squares regression plot of all the datasets (i.e., descriptive, chemical, quality, and preference datasets). We concluded that the definition of a high-quality and well-liked Pinot noir wine is one with a dominant red or dark fruit sensory profile, slightly sweeter, and with higher alcohol content.

Protein Stabilization in Wine with Phytic Acid

Brent C. Trela*

Department of Viticulture and Enology, UC Davis Extension, Davis, CA 95616
[trelab@alertaesthetics.com]

An alternative method of standard protein (bovine serum albumin; BSA) stabilization for a model wine was investigated at laboratory scale using phytic acid, a form of phosphorus storage in plants. Treatments with increasing doses of phytic acid resulted in exponential BSA reductions of >99.9% at phytic acid:BSA molar ratios >6.5:1 at a BSA concentration of 1000 mg/L, and linear reduction at a BSA concentration of 200 mg/L. However, the effects on both the sensory perception and the long-term stability of wines treated with phytic acid need to be determined under actual winemaking conditions.

New Perspectives in Wine Oxidation

Andrew L. Waterhouse* and Ryan J. Elias

Department of Viticulture and Enology, University of California Davis, CA 95616
[alwaterhouse@ucdavis.edu]

Wine oxidation is an old problem and understanding it has been a slow, incremental process. We recently proposed a comprehensive theory that provided a pathway of wine oxidation, a pathway that can be systematically tested by experimentation. To that end we have a new analytical method to measure one class of oxidation products, the aldehydes and ketones. This method converts these products to their dinitrophenylhydrazones and quantifies them by HPLC. We have used this method and others to search for new oxidation products and to study the rate and extent of oxidation in wine under different conditions. Our results and those of others indicate that critical factors in wine oxidation include metals, sulfites, and phenols. Future studies must investigate the specific interactions of those components under different conditions to provide winemakers with useful guidance in controlling wine oxidation.

Sun Exposure of Cabernet franc Grapes and Its Effects on Grape and Wine Composition

Paul E. Brock II,* Alan Lakso, Terry Acree, and Thomas Henick-Kling

Department of Food Science and Technology, New York State Agricultural Experiment Station, Cornell University, Geneva, NY 14456 [peb36@cornell.edu]

Wine style and quality is directly related to the composition of the grapes used in its production. Current practices of leaf removal and canopy manipulation in cool climates are adapted from warm-climate studies. However, sun exposure is widely believed to have different effects on ripening characteristics in cool climates than in warm climates. A better understanding of the relationship between sun exposure and winegrape composition in cool climates may help to realize more consistent grape quality. Cabernet franc is an important red variety in cool-climate regions. Leaf pulling was used in the fruiting zone of vertically shoot-positioned Cabernet franc vines to achieve five degrees of sun exposure in a commercial vineyard. Leaf pulling of 0, 25, 50, 75, and 100% was defined in mid-July about two weeks after fruit set when the berries were pea size. Leaf pulling

resulted in actual photosynthetic active radiation reaching the fruit of 39, 44, 58, 60, and 67% for the respective defined leaf removal. Ripening was monitored in all treatments by sugar, acid, and pH measurements. No treatment effects on these parameters were noted throughout the growing season. Replicated wines were made for each treatment. The wines have shown increasing concentrations of total phenols, tannins, and anthocyanin with increasing sun exposure. Quantitative gas chromatography-mass spectrometry with external standards was used to determine that 3-isobutyl-2-methoxypyrazine was below 2 ppt in all wines. Sensory evaluation will be carried out on these wines after they are 6 months old.

Ammonium Addition during Fermentation by Wine Yeasts: Effect of Quantity and Moment of Addition

Patricia Taillandier,* Felipe Ramon-Portugal, Pierre Strehaiano, Gaelle Reynou, André Fuster, and **Christophe Doux**

Laboratoire de Génie Chimique, UMR INP-CNRS 5503, 31106 Toulouse, France
[Patricia.Taillandier@ensiacet.fr]

The objective of this work was to evaluate the relevance of nitrogen addition in two times on deficient grape must during fermentation by two wine yeasts from Lamothe-Abiet. The must, from Sauvignon variety, was diluted to 120 mg/L assimilable nitrogen and then completed with thiamine and sugars (50% glucose and 50% fructose) up to 240 g/L. For the two yeast strains, two assimilable nitrogen levels were studied: 190 and 240 mg/L. For each level ammonium sulfate was added in two ways: 100% before must inoculation or 50% before inoculation and 50% at the third day of fermentation (yeast growth phase). The growth and fermentation kinetics were determined as well as the consumption of assimilable nitrogen. The yeast growth was better when all nitrogen was added at the beginning and for the highest total concentration. The same observation was made for sugar consumption, except for one strain at 190 mg/L. Glucose was always exhausted and residual sugar was only fructose. Ammonium salts influenced only fructose consumption. In all cases the consumption of assimilable nitrogen was total at any concentration and moment of addition. Results suggest that the addition of ammonium salts in winemaking does not seem necessary several times if the quantity added is not excessive.

Survey of Phenolic Constituents of Merlot and Cabernet Sauvignon Wines Produced in Washington State

James Harbertson,* Barbara Zimmermann, and Lisa Baldwin

Irrigated Agriculture Research and Extension Center, Washington State University,
Prosser, WA 99350 [jharbertson@wsu.edu]

Washington State Cabernet Sauvignon (n = 186) and Merlot (n = 131) wines were analyzed in duplicate for phenolic constituents using a combined bisulfite bleaching, protein precipitation, and pH shift analysis. Samples were taken from multiple vintages of wine ranging from 1990 to 2004, but the majority of samples were from 2002 and 2003. Merlot wines were on average significantly less tannic than Cabernet Sauvignon, averaging 610 and 701 mg/L catechin equivalents (CE) respectively ($p < 0.01$). A 12-fold range of tannins was found for both cultivars

(141–1665 mg/L CE, 158–1895 mg/L CE), with the latter range attributed to Cabernet Sauvignon. In agreement with earlier studies, our data demonstrated that the concentration of color components is time dependent. Wines aged more than 5 to 7 years in the bottle had converted most of their anthocyanins into polymeric pigments. Other than color, tannins were the most variable phenolic group, and when wines made from different grape-growing regions were compared across all vintages, some notable differences were observed among the Cabernet Sauvignon wines. For Cabernet Sauvignon, Red Mountain wines (average = 843, n = 22) were noticeably more tannic than wines from Walla Walla (average 537, n = 27) and Yakima Valley (average = 653, n = 38), while the wines from Columbia Valley were not different (average 737, n = 91). The tannin content of Merlot wines was not as variable and only Red Mountain (average 829, n = 13) was greater than Columbia Valley (average 582, n = 69), Yakima Valley (average 560, n = 29), and Walla Walla (average 547, n = 22).

Effect of Wine Dilution on the Reliability of Tannin Analysis by Protein Precipitation

Jacob Skibsted Jensen, Hans Henrik Malmberg Werge, Max Egebo, and Anne S. Meyer*

Department of Chemical Engineering, Technical University of Denmark, 2800 Kgs. Lyngby, Denmark [am@kt.dtu.dk]

Tannins play an important role in the mouthfeel properties and color stability of red wines and are therefore related to wine quality. Reliable quantitative analysis of wine tannins is challenged by the chemical diversity of tannins and the analytical methods available. The purpose of this study was to investigate the influence of dilution degree on the reliability of tannin analysis by protein precipitation. The method relies on the observation that tannin can be separated by precipitation with bovine serum albumin and measured by a color reaction with ferric chloride. Dilutions of five commercial red wines were analyzed by protein precipitation and the linear relationship between the inverse dilution factor and the measured tannin content was evaluated. Although linear relationships were generally observed, all wines caused negative intercepts, which can be explained by precipitation threshold theory. In addition, several dilutions with high tannin content deviated from the linear relationship, likely because of insufficient protein for the precipitation step. Considering the substantial impact of the intercept for highly diluted wines and the need for sufficient protein for the precipitation step, we have defined a valid range of the tannin measurements, where the tannin precipitation suffers minimally from the described problems.

Optimizing Greenhouse Evaluations of Pierce's Disease Resistance

Jeremiah Baumgartel and M. Andrew Walker*

Department of Viticulture and Enology, University of California, Davis, CA 95616
[awalker@ucdavis.edu]

Pierce's disease (PD) is caused by the xylem-limited bacterium *Xylella fastidiosa* and is widespread throughout the southern United States and Mexico. The disease is prohibitive to the cultivation of grapevines in these areas and continues to pose a threat to the table and winegrape industries in California. The use of marker-assisted selection has been used to aid in the breeding of cultivars carrying the *PdR1* gene, which confers resistance to PD. A greenhouse screening procedure is used to quantify the resistance levels in candidate genotypes carrying *PdR1*. The procedure measures *X. fastidiosa* levels in stems with ELISA. These data are then used to select the genotypes that show the highest levels of resistance for backcrossing to existing *Vitis vinifera* table and winegrape cultivars. When the greenhouse screening method was modified with smaller pots in sub-irrigated trays, resistant plants were no longer resistant. Two sets of experiments were carried out to determine the reason for this discrepancy/breakdown. Inoculation levels were varied, along with incubation duration and irrigation technique. Below-ground biomass was measured to determine the role that roots might play in the development of resistance to *X. fastidiosa*. The second experiment used three pot sizes of varying aspect ratios and soil volumes in two irrigation regimes. The vertical height of the vines was altered to assess the role of leaf area in the resistance response. This research is critical to the breeding program and may help in our understanding of PD resistance.

Climatic Impacts on California Cabernet Sauvignon Wine Quality

Charles A. Reisman, Katharine Hayhoe, Jeff Van Dorn, Kimberly Nicholas Cahill, Edwin P. Maurer, Mark A. Matthews, and David E. Block*

Department of Viticulture and Enology, University of California, Davis, CA 95616
[deblock@ucdavis.edu]

Differences in annual weather patterns are the single largest contributor to variations in wine vintage quality for a given region. Climate effects on grapes have typically been correlated with seasonal heat summations and accumulated precipitation, ignoring potential effects of the timing of climatic events and long-term trends in temperature and precipitation due to global climate change. We present a genetic programming approach to build validated models correlating historical weather patterns with wine quality and map predicted suitability for Cabernet Sauvignon cultivation across California. Combining the most successful predictive quality models with climate change projections, we then estimate the extent of changes that might be expected over the coming century for California viticulture. In general, climate change impacts have the potential to significantly alter the scope of the California wine industry by the end of this century, including reducing quality in the Central Valley while increasing quality along the coast.

Modeling Climate and Climate Change Impacts on Winegrape Yields in California

Kimberly Nicholas Cahill,* David B. Lobell, Christopher B. Field, Celine Bonfils, and Katharine Hayhoe

Department of Global Ecology, Stanford University, Stanford, CA 94305
[kncahill@stanford.edu]

Improved assessment of winegrape yield responses to future climate is needed to understand potential damages from climate change and to prioritize adaptation strategies. We evaluated the effect of climate change on winegrapes in California using outputs from multiple climate models to evaluate climate uncertainty, multiple emissions scenarios to evaluate uncertainty in emission pathways, and multiple statistical yield models to evaluate yield response uncertainties. Our model found higher yields associated with moderate nights in April and higher precipitation in June and the October proceeding harvest ($R^2_{adj} = 0.66$). We found that winegrape yields in California are likely to experience a decline of 5% by the end of the century if future yield changes from climate do not exceed historical extremes, with 90% confidence intervals including both climate and crop uncertainties of +8 to -13%. If future yield changes do exceed historical extremes, then yields are likely to decline by 10% (90% confidence intervals: +10 to -39%). The areas modeled to have high yields overlap with the currently planted areas, but shift toward the coast and the north with future warming. While winegrape yields are highly manipulated by viticulturists, a warming climate may limit management options by stressing the growing and ripening capacities of vines.

Grape Rootstock Germplasm Resistance to Root-Knot Nematodes (*Meloidogyne* Species)

Peter Cousins*

USDA-ARS, Grape Genetics Research Unit, Cornell University, New York State Agricultural Experiment Station, Geneva, NY 14456 [peter.cousins@ars.usda.gov]

Development of rootstocks with resistance to (*Meloidogyne* spp.) is a top priority in grapevine breeding. New sources of resistance to aggressive root-knot nematodes are needed to address the challenge posed by the root-knot nematodes that can reproduce on the rootstocks Freedom and Harmony. To identify additional nematode resistant grape rootstock germplasm, 20 accessions were evaluated. Most of the accessions tested are part of the United States national grape variety collection, which is held at the USDA ARS Plant Genetic Resources Unit (Geneva, NY) and the USDA ARS National Clonal Germplasm Repository (Davis, CA). Green-growing cuttings of test accessions and controls were rooted and then cultivated in small pots in a greenhouse. Each small plant was inoculated with approximately 1500 second-stage juveniles of Harmony virulent *Meloidogyne* sp. Reproduction was measured by counting the number of stained nematode egg masses visible per root system. Many accessions demonstrated resistance against this nematode population. The putative sources of resistance in these accessions are *Vitis mustangensis*, *V. rotundifolia*, *V. x champinii*, and *V. cinerea*. IAC 572 (variety Jales), a tropical or subtropical adapted rootstock developed in Brazil, supported some nematode reproduction.

The highly resistant accessions identified in this study should be considered for direct use as rootstocks and for use as parents in rootstock breeding.

Soil Physical and Chemical Properties and Wine Characteristics in a Paso Robles Vineyard

Jean-Jacques Lambert*, James A. Wolpert, Randal A. Dahlgren, and Mark Battany

Department of Viticulture and Enology, University of California, Davis, CA 95616
[jjlambert@ucdavis.edu]

The effects of soil physical and chemical properties on the perceived quality of wines have been the subject of many assumptions and much speculation. However, little is known about how soil properties affect vine nutrition and fruit composition in a way that directly impacts wine properties. Small-lot wines were made from Cabernet Sauvignon grapes grown on four distinct soil types present in the same Paso Robles vineyard, and the wines exhibited different sensory attributes during an informal tasting. To determine the influence of four contrasting soil types on vine growth and wine chemistry, the soils were described and analyzed for physical and chemical differences. The soils cover contiguous vineyard patches planted with the same cultivar, on its own roots, and managed uniformly. Mesoclimatic conditions and slope aspect are similar, and the profiles examined are less than 250 m apart. The soils were classified as belonging to the Great Groups of Palexeralfs, Haploxeralfs, Haploxerolls, and Haploxererts. These soils exhibit important morphological differences in color, coarse fragment content, texture, water-holding capacity, and hydraulic conductivity. The soils also show differences in mineralogy, relative proportion of clay minerals in the colloidal fraction, and organic matter content and quality. Varying properties between the four soils likely impact the cation exchange capacity and nutrient availability in the soil solution and contribute to the differences among the wines.

Effect of Rootstock on Chilling Requirement of Grape cv. Perlette

Arnulfo Marquez* and Gerardo Martínez

INIFAP-CECH, Carretera a Bahía de Kino, Hermosillo, Sonora, México
[armarce44@yahoo.com.mx]

In the desert of Sonora, Mexico, it is common to have warm winters that reduce the percentage of budbreak, the late varieties being most affected. The stages of phenology of the grapes are delayed when they are on rootstocks as compared with plants on their own root, which might be associated with a change of the chilling requirement of the cultivars under that condition. The experiments were conducted in the grape cv. Perlette. Shoots from grapes on their own root or on the rootstocks Salt Creek or Freedom were collected in the fall and exposed to 0, 50, 100, 150, and 200 chilling hours (hours at 4°C) and were then transferred to a growing chamber at 22°C. The evaluation of budbreak was conducted 20 days after transfer. The shoots collected from grapes on their own root required 100 chilling hr to achieve a budbreak of 50%, while those on rootstock required 150 hr to attain the same percentage of budbreak. These results indicate that the rootstock increased the requirement of chilling hours of cv. Perlette.

Effect of Rootstocks on Amino Acid Content of Grapevine Scions

Erik Tarczal, Laszlo Kocsis,* Peter Podmanczky, and Zoltan Varga

Department of Horticulture, Georgikon Faculty of Agriculture, University of Pannonia, Keszthely 8360, Hungary [kocsis-1@georgikon.hu]

Rootstocks have different effects on the growth and composition of the scion. We investigated the effect of rootstock on scion amino acid composition and concentration. Experiments were conducted in Cserszegtomaj, Hungary in 2004 at the experimental field of the University of Pannonia (46°49'45"N; 17°15'16"E). *Vitis vinifera* cvs. Kekfrankos and Cabernet Sauvignon were grafted to five different rootstocks: Teleki SO4, Fercal, Georgikon 28, Teleki-Kober 5BB, and Teleki 5C. Line width was 2.9 m and vine separation was 1 m on a north to south orientation. Cane samples were collected during dormancy. Amino acids examined were proline, glutamines, lysine, asparagine, and glycine. The examined samples showed a high degree of similarity in amino acid composition. There was a high degree of difference among the scions grafted on different rootstocks in the quantity of amino acids as related to the weight of the shoot. The composition of the different rootstocks and of the grape berries and wines was also evaluated.

Water Loss from Fresh Berries of Raisin Varieties under Controlled Drying Conditions

David W. Ramming*

United States Department of Agriculture, Agricultural Research Service, Parlier, CA 93648 [dramming@fresno.ars.usda.gov]

Thompson Seedless ripens late and is not well suited for drying-on-the-vine (DOV) for mechanical harvest. Newly developed, early ripening raisin varieties are better suited. Different fruit drying rates have been observed for varieties in the field and differences due to berry characteristics need to be determined and separated from cluster or vine characteristics. Fresh berries of Thompson Seedless, Summer Muscat, Selma Pete, DOVine, Diamond Muscat, and Primus were harvested in 2002, 2003, and 2004. They were separated into two berry diameters (12.7 and 14.3 mm) and three sugar levels (20, 22, and 24 Brix). They were dried at 52°C (2002) and 38°C (2003, 2004). In 2003, the effect of removing the surface berry wax was tested. There was no significant difference for water loss between berry sizes. A trend exists for small berries to lose water more rapidly. Berries with 20 Brix had significantly higher water loss rates than 22 and 24 Brix. There were significant differences among variety water loss rates within the different years. Summer Muscat had the highest water loss except in 2003 when it had the second fastest water loss rate. Thompson Seedless had the lowest water loss rate except in 2004. The removal of wax with chloroform increased the water loss rate by up to 2.5 times. Wiping the berry was not as effective as chloroform for increasing water loss rates but significantly greater than the control. Even with the removal of wax, there were still significant difference in water loss between Thompson Seedless and Summer Muscat.

Allelic Diversity of *PdR1* in *Vitis arizonica/candicans* Selections from Monterey, Mexico

Joshua R. Rubin and M. Andrew Walker*

Department of Viticulture and Enology, University of California, Davis, CA 95616

[awalker@ucdavis.edu]

Pierce's disease (PD) is endemic across the southern United States and Mexico where it severely limits commercial grapevine cultivation. Introducing PD resistance from native cultivars into *Vitis vinifera* through breeding programs or genetic modification should provide a sustainable solution. Multiple sources of resistance first need to be clearly identified and evaluated. Four geographically related selections from Monterey, Mexico (*V. arizonica/candicans*), b43-15, b43-17, b43-36, and b43-56, were previously crossed with *V. vinifera* wine and table grape varieties. In the present study, these populations (04351: b43-15 x C90-100; 04373: F2-35 x b43-17; 04374: F2-35 x b43-36; and 04375: F2-35 x b43-56) were screened with 10 SSR markers flanking the PD resistance locus, *PdR1*, previously characterized in b43-17. Dormant cuttings of parents, progeny, and controls were taken from UC Davis vineyards and each genotype was replicated four times in a randomized block design. Vines were inoculated with the bacterial pathogen *Xylella fastidiosa* (Xf), and resistance was evaluated using ELISA to quantify Xf levels in plant tissue. The performance of progeny from these crosses will be compared to control vines with low, medium, and high levels of resistance. This project will help identify genotypes that may be used in future breeding efforts to develop PD resistant wine and table grape cultivars.

Alleyway Cover Crops Have Little Influence on Pinot noir Performance

Rebecca Sweet and **R. Paul Schreiner***

USDA-ARS, Horticultural Crops Research Laboratory, Oregon State University, Corvallis,

OR 97330 [schreiner@science.oregonstate.edu]

Competition between Pinot noir grapevines and alleyway cover crops was evaluated in two commercial vineyards in western Oregon. Seven cover-crop treatments including a clean-cultivated control were applied in fall 2003 and their impact on vines was monitored in 2004 and 2005. Competition with grapevines was assessed by measuring soil moisture, vine growth, vine water status, vine nutrient status, yield, and must quality over two years with typical weather patterns for the region. Despite large treatment differences in cover-crop biomass and nitrogen (N) contributions to the soil from mowed residues, cover crops had little measurable influence on vine growth or fruit quality. Small differences in alleyway soil water content, leaf nitrogen, and juice YANC were found between different treatments; however, no cover-cropped treatment differed from the clean-cultivated control. Alleyway cover crops managed by spring and summer mowing do not appear to compete significantly with established Pinot noir grapevines in western Oregon vineyards. Therefore, advantages of using cover crops (e.g., protection against soil erosion and addition to soil organic matter) can be realized without impacting vine productivity or juice quality. The long-term impact of certain cover crops, including the clover mix we used, could result in the supply of too much N to vines, an aspect that should be further examined.

Effect of Double Maturation Raisonée Technology and Cluster Thinning on Quality of Harvest and Wine

Peter Podmaniczky, Laszlo Kocsis,* Zoltan Varga, and Erik Tarczal

Department of Horticulture, Georgikon Faculty of Agriculture, University of Pannonia, Keszthely 8360, Hungary [kocsis-1@georgikon.hu]

In general, lower yields are associated with higher quality wine. We investigated the use of cluster-thinning and double maturation raisonée (DMR) methods on wine composition. Experiments were conducted in Koroshegy, Hungary (46°50'39"N; 17°50'31"E). Pinot blanc, Chardonnay, Rainer Riesling, and Pinot noir varieties on T5C rootstock were planted to a line width of 2.5 m, with 0.9 m vine separation. The cluster-thinning treatment was conducted on clusters of 10 Brix. The DMR treatment was conducted on shoots 2 to 10 days before harvest. In both treatments, weight was reduced up to 2000 grams and both sugar (30.5 Brix) and acid (11.1 g/L) increased. Harvested grapes were processed and fermented to wine, and pH, sugar, acid, and extract content were measured. Higher levels of sugar, acid, and extract contents were associated with DMR. DMR resulted in the greatest differences in extract content. The highest value of extract was 34.6 g/L. The amount of extract in cluster thinning was consistently lower. Wines were subjected to sensory analysis after five months, in a 100-point system using a panel. DMR treatment wines received higher ratings in flavor and aroma. Cluster-thinning treatment wines received lower ratings, depending on variety. DMR technology had a positive effect on the perceived quality of the wine, depending on the variety.

Rapid Measurements of Red Grape Color for Wine Quality Improvement

Jon S. Gethner* and Steve Kupina

Adaptive Analyzer Technologies, New York, NY 10001 [jon7@analyze.com]

The color value of red grapes has become recognized as one of the significant indicators of the quality of red wine. Rapid analysis techniques allow color to be used in numerous ways, both to improve the quality of the resulting wine and to develop new methods for economic valuation of the fruit. Rapid spectroscopic analysis using near infrared spectroscopy (NIRS) is described. The NIRS analysis is illustrated with results from a bench-top unit (analysis time approximately 15 sec) and a portable unit suitable for single berry analysis (analysis time 1 sec). Data obtained both from the bench-top unit and the portable unit are compared so that the trade-offs between the two types of instrumentation can be assessed. Strategies for the use of such NIRS color value data for berry and wine quality improvement are discussed.

Comparing Performances of Planted and Unplanted Gravel Beds for Treating Winery Process Wastewater

Heather Shepherd*

Wallace Group, 1330 Arnold Drive, Martinez, CA 94553 [heathers@wallacegroup.us]

Questions have been raised regarding the role plants play in the performance of constructed wetlands (CWs) for wastewater treatment. In the wine industry, CWs are selected for treatment reliability, low cost, aesthetic appearance, and low energy requirements. Constructed wetland theory suggests that plant roots provide the structure for bacteria required for process wastewater treatment. Nonetheless, in some cases aesthetic appearance is not a concern, and the need for plants and associated costs is questioned. To address this issue, CWs at two wineries were monitored during peak harvest. In both cases, the CW systems consisted of a planted CW bed and an unplanted bed side by side at the same winery. Flows from the wineries were split equally between the two beds, and water samples were taken daily for two weeks during peak harvest. Effluent from the planted CWs at both wineries contained lower chemical oxygen demand and total dissolved solids concentrations, lower suspended solids, and pH values closer to neutral consistently throughout the experiment. The other parameters measured included calcium, magnesium, sodium, chloride, boron, carbonate, nitrate, and ammonium, analysis of which is pending receipt of laboratory data.

A Colorimetric α -Amylase Inhibitor Assay as a Measure of Hydrolyzable Tannins in Wine and Juice

Lorin Hills*

Infinetix, 2721 N. Van Marter, Spokane, WA 99206 [lhills@infinetix.com]

Hydrolyzable tannins form an important class of phenolics defined by the dual properties of binding and precipitating proteins and undergoing hydrolysis by mild alkali or acids or by esterases. We verified that the most prevalent and available member, tannic acid, inhibited α -amylase and found that following hydrolysis, the inhibition disappeared. Furthermore, most individual unbound products

of hydrolysis of hydrolyzable tannins did not cause inhibition. We tested glucose, quinic, gallic, and coumaric acids. We developed an assay for tannic acid using an α -amylase synthetic substrate and laboratory spectrophotometer. Dilute solutions were used to avoid precipitation or tannic acid-amylase binding other than at the active site. The resulting assay for tannic acid was linear, precise, and convenient. We next explored the application of this assay to wines and juices and adjusted for possible complications: (1) interference from other inhibitors, (2) preexisting amylase from plants, juice, or yeast, and (3) winery-added amylase for clearing or speeding fermentation. To adjust for preexisting amylase activity, wine samples were measured before and after hydrolysis and percent inhibition was used as the measure of tannic acid equivalents (TAE) from the standard curve of the tannic acid assay. We assumed the presence of nonhydrolyzable inhibitors would result in less than the added amylase activity upon hydrolysis. We measured a series of wines and found a range 50 to 170 mg/L (TAE) for hydrolyzable amylase inhibitors. We found no inhibition with moderate preexisting amylase activity in white juice and measured moderate inhibition with high preexisting activity in red must.

Development of a Mixed *Saccharomyces cerevisiae* Starter Perrine Languet*

Lallemand SAS, 31702 Blagnac, France [planguet@lallemand.com]

In the last 15 years, a trend in winemaking has been the use of selected natural active dry yeast (ADY) in a pure form to control alcohol fermentation and avoid sensory deviations. A logical evolution could be the introduction of different wine yeast strains with various technological properties in the same ADY starter. At both laboratory and winery scale, related experiments were conducted, but they relied on empirical approaches based on the consequences of yeast population evolution. In order to rationalize the use of mixed ADY starters and to analyze the potential interaction mechanisms between the different yeast strains, Lallemand focused its research on innovative mixed ADY starters, with high fermentative capacities and increased red wine sensory properties. Two yeast strains were selected for their synergy: one considered as rustic with good fermentative capacities and relatively low nutritional needs, the other considered as improving red wine sensory properties, but on occasion exhibiting sluggish fermentations under difficult conditions. At the laboratory level, the formulation of this mixed ADY starter was based on an extensive on-line monitoring of fermentation rate to study the behavior of each yeast strain in several synthetic media simulating nutrient-limiting grape musts. Different mixed ADY starters were then tested for their suitability for achieving difficult fermentations. Winery-scale fermentations in actual musts were carried out and sensory panel results confirmed the initial expectations: wines obtained by mixed ADY did not show significant sensory differences than wines obtained by a single sensory-enhancing strain. However, fermentation kinetics of the mixed ADY did show significantly better fermentation kinetics than the single sensory-enhancing strain.

Effect of Crop Load Adjustment on Fruit Ripening, Uniformity, and Sensory Characteristics

Michael M. Anderson, Hildegard Heymann, Jason Benz,
G. Stanley Howell, and James A. Wolpert*

Department of Viticulture and Enology, University of California, Davis, CA 95616
[jawolpert@ucdavis.edu]

Crop reduction solely for expected improvement in fruit uniformity and flavor is widely practiced by wine grapegrowers. Although widespread, the practice has little supporting experimental data. Our experiment was designed to investigate the effectiveness of crop reduction as a tool to modify fruit ripening, uniformity, and sensory characteristics. Treatments consisted of two levels of whole cluster removal (20 and 40%) at three stages of fruit development (pea, veraison, and 21 Brix). Yield, fruit chemistry, fruit uniformity, and fruit sensory characteristics were measured in response to these treatments. Cluster thinning accordingly influenced yield but did not affect berry weight or berries per cluster. Differences in Brix, pH, and titratable acidity were significant but small and diminished as the season progressed. Soluble solids measurements showed significant differences 50 days before harvest; however, by harvest, fruit from unthinned vines had the highest Brix values. Uniformity of ripening (Brix level) was investigated both as whole clusters and within clusters. Curves describing population distribution were striking in their similarity and suggest a ripening limit for most fruit. A trained taste panel found that thinning treatments significantly influenced five sensory characteristics of the 18 parameters evaluated, including sourness, sweetness, and fruitiness of the pulp of fruit from two treatments at the same level of soluble solids.

Impact of Training System on Berry Composition and Wine Quality of Syrah

David Sorokowsky*

RH Phillips Wine Co., 26836 County Road 12A, Esparto, CA 95627
[David.Sorokowsky@cwine.com]

Syrah vines planted in an east-west row orientation were subjected to three canopy treatments over a three-year period. Smart-Dyson was compared to a modified Smart-Dyson canopy where the vines were allowed to sprawl on the south side (southern sprawl) and to a fully sprawled canopy. The southern sprawl treatment resulted in the smallest berries in two of the three years of this study and also produced the lowest cluster weight. Fruit from the southern sprawl treatment had higher Brix and total phenols than the control and full sprawl in two of the three years. Sensory analysis of wines produced in 2005 was carried out and the southern sprawl treatment wine had higher blueberry and lower vegetal aromas than both the Smart-Dyson and fully sprawled treatments. The southern sprawl treatment also had the highest anise flavor and was the least astringent. These data suggest that a modified Smart-Dyson training system, allowing the south side to sprawl on east-west oriented rows, may improve wine quality while reducing labor inputs required for training to traditional Smart-Dyson canopy.

Impact of Deficit Irrigation on Aroma Composition of Merlot Wine

Michael C. Qian*, Yu Fang, and Krista Shellie

Department of Food Science and Technology, Oregon State University, Corvallis, OR 97331 [michael.qian@oregonstate.edu]

Water status during berry development directly affects vine physiology and secondary metabolism of the plant. Since volatile compounds are the secondary metabolites of the grapevine, it is postulated that their formation in the grapes will be affected by water status. The objective of this study was to investigate the impact of vine water status during berry development on the wine aroma profile of Merlot. Own-rooted Merlot vines grown in a commercial vineyard in Idaho were supplied throughout berry development with 100% or 35% of their estimated crop evapotranspiration needs. Wines were produced from 2002, 2003, and 2004 growing seasons. Thirty aroma-active compounds in the wines were quantified using stir bar sorptive extraction-gas chromatograph-mass spectrometry (SBSE-GC-MS). The results demonstrated that despite annual differences in amount of all aroma volatiles in each of three years of this study, deficit irrigation during berry development had a consistent effect on the aroma composition of the wine, especially on C13 norisoprenoids. Wine produced from deficit-irrigated vines had an increased amount of β -damascenone and decreased amount of β -ionone relative to wine produced from well-watered vines.

Influence of Sunlight Exposure on Monoterpene Accumulation in the Interspecific Hybrid Traminette

Patricia A. Skinkis* and Bruce P. Bordelon

Department of Horticulture, Oregon State University, Corvallis, OR 97330 [skinkisp@hort.oregonstate.edu]

Traminette, a French-American hybrid winegrape variety produced from a cross of JS 23.416 x Gewürztraminer, is of increasing interest in the Eastern wine industry because of its cold hardiness and potential to produce quality white wines of Gewürztraminer-like character. Monoterpenes are the major odor impact aroma compounds in this variety, and research suggests berry monoterpene production is influenced by solar radiation and shading. Various shade regimes and vine training systems were used to determine the influence of sunlight exposure on increased monoterpene accumulation in fruit. Samples were collected during the ripening phase and at harvest for fruit analysis and wine production. Fruit monoterpenes were quantified using a rapid distillation technique, and wine/fruit aroma profiles were determined with gas chromatography. Sunlight exposure treatments had greater impact on monoterpene glycosides than aglycones. Berries from fully exposed clusters (55% ambient sunlight) contained 22% higher concentrations of monoterpene glycosides than heavily shaded berries under >3 leaf layers of canopy (<2% ambient sunlight). No differences in monoterpene concentrations were found with training systems; however, the wines had different volatile and sensory profiles. This may suggest a dynamic change in monoterpene profile with differences in cluster-zone shading. All treatment wines were dominated by floral, spice, apricot, and citrus aromas that are related

to their monoterpene constituents. *Cis*-rose oxide was found as the most odor active aroma compound in Traminette fruit among 17 monoterpenes and four norisoprenoids.

Effects of Irrigation Levels during Final Stages of Ripening on Yield and Wine Composition

Martin P. Mendez,* Luis A. Sanchez, Nick Dokoozlian, Jim O'Donnell, and M. Andrew Walker

Horticulture and Agronomy Graduate Group, University of California, Davis, CA 95616
[pmendez@ucdavis.edu]

The effects of irrigation regime during the final stages of fruit ripening on yield components, vine physiology, and berry and wine composition were studied in field-grown Cabernet Sauvignon (Sonoma County) and Merlot (Madera County) grapevines in California. All vines in the study were drip-irrigated at the commercial standard deficit irrigation amount (0.6 ET_c) until the fruit reached 20 Brix. After reaching 20 Brix, irrigation amount was increased to 1.2 ET_c on one set of vines while the other set were maintained at 0.6 ET_c. Fruit composition was determined weekly following treatment initiation, and wines were made four times during the ripening period beginning at 22 Brix. Reductions in berry weight, cluster weight, and total vine yield during ripening were smaller in vines irrigated at 1.2 ET_c compared with vines at 0.6 ET_c. However, irrigation levels had little effect on fruit and wine composition. Irrigation had no effects on total vine leaf area, but a higher percentage of the total leaf area was senescent in the 0.6 ET_c vines one week after commercial harvest. Vines receiving 1.2 ET_c during the final stages of ripening had greater levels of leaf chlorophyll, higher carbon assimilation rates, and reduced midday leaf water potential compared with vines irrigated at 0.6 ET_c. These results indicate that increasing irrigation amounts during the latter stages of ripening (≥20 Brix) may mitigate yield losses due to berry dehydration without decreasing fruit and wine quality.

Electronic Nose Evaluation of Cabernet Sauvignon Fruit Maturity

Ahmad I. Athamneh,* Bruce W. Zoecklein, and Kumar Mallikarjuna

Biological Systems Engineering, Virginia Tech, Blacksburg, VA 24061 [athamneh@vt.edu]

The ability of an electronic nose to classify Cabernet Sauvignon (*Vitis vinifera* L.) fruit based on maturity was investigated over two seasons. Maturity of samples collected 18, 19, and 20 weeks postbloom was evaluated by measuring berry weight, pH, Brix, titratable acidity, total phenols, color intensity, hue, total anthocyanins, and total and phenol-free glycosides. Results were compared using discriminant and canonical discriminant analysis with analysis of headspace volatiles via a hand-held electronic nose. The electronic nose was able to determine the difference among the three sample groups in both seasons. Electronic nose measurements were also compared to chemical analyses of samples collected from east and west sides of the vine canopy. Results demonstrated the ability of the electronic nose to distinguish maturity levels on both canopy sides. Field measurements demonstrated the potential for the electronic nose as a rapid, nondestructive tool for evaluating grape maturity.

Fast Aroma Analysis of Cabernet Sauvignon and Riesling Grapes Using an Electronic Nose

Amalia Z. Berna,* Stephen Trowell, David Clifford, Glenn Stone, and David Lovell

CSIRO Food Futures Flagship, Clunies Ross St., Canberra, ACT 2601 Australia
[amalia.berna@csiro.au]

Winemakers use a range of objective measurements to assess grape juice, musts, and wines at various stages of preparation and maturation. The most widely applied and established methods include soluble solids content, pH, and titratable acidity, which are rapid techniques that can be automated. Quantification of volatile compounds in wine and grapes requires the use of sensory and/or chromatographic techniques, which involve significant time for sample preparation and analysis and are difficult to implement as routine quality-control measures. Electronic nose (e-nose) technology offers a fast alternative for sensing volatiles and could be used to detect, for example, differences in the headspace composition of grapes grown in different regions. In this study, a metal oxide based e-nose was used to investigate the aroma of grapes harvested from five southern Australian valleys. Cabernet Sauvignon and Riesling grape juice and slurry were collected at Orlando Wines. Samples were analyzed for free volatiles by an Alpha MOS e-nose using both static headspace sampling (SHS) and solid-phase microextraction (SPME). GC-MS analysis was also performed. Linear discriminant analysis of the e-nose data showed that in general SHS was superior to SPME for discriminating among different regions. Using SHS, the misclassification of juice samples for both Cabernet Sauvignon and Riesling grapes was 13%, while for slurry samples it was 15%. With appropriate choice of samples and methodology, volatile measurement by e-nose may be a useful practical tool to estimate, for example, the time to ripeness of grapes.

Estimated Sensory Thresholds of *Harmonia axyridis* in Winegrapes

T.L. Galvan,* E.C. Burkness, Z. Vickers, A.K. Mansfield, and
W.D. Hutchison

Department of Entomology, University of Minnesota, St. Paul, MN 55108
[galva008@umn.edu]

Sensory thresholds were developed for the Frontenac winegrape to aid growers in the management of the multicolored Asian lady beetle, *Harmonia axyridis* (Pallas) (Coleoptera: Coccinellidae), a recent and devastating contaminant pest in the midwestern and eastern United States. We estimated sensory thresholds for the *H. axyridis*-related taint in winegrapes by artificial infestation of *H. axyridis*-free grapes with live adults. A tasting panel evaluated a series of three-alternative forced choice (3-AFC) tests that compared control wine prepared with *H. axyridis*-free grapes and wine produced with increasing insect levels. Logistic regression was used to relate the number of *H. axyridis* per kg of grapes to the proportion of correct 3-AFC tests, and the probability of correct answers was estimated using the logit probability function. The same logistic model was also used to estimate the infestation level (i.e., number of *H. axyridis* per kg of grapes) for a given probability of correct answers. For example, the estimated threshold at which 10% of the population would be able to detect the characteristic off-flavor of *H. axyridis* was 1.9 beetles per kg of grapes, or 0.27 beetles per grape cluster of Frontenac. These sensory thresholds can be interpreted as action thresholds for *H. axyridis* in winegrapes, thus contributing to the development of an objective integrated pest management program for *H. axyridis* in winegrapes.

Impact of SO₂ on Culturability and Viability of *Brettanomyces* in Wine

Nicole L. Umiker and Charles G. Edwards*

Department of Food Science and Human Nutrition, Washington State University, Pullman, WA 99164 [edwardsc@wsu.edu]

Brettanomyces bruxellensis is one of the most influential spoilage microorganisms affecting the wine industry worldwide. Methods to differentially stain viable, injured/dying, and dead cells using carboxyfluorescein diacetate succinimidyl ester (CFDA-SE) and propidium iodide (PI) were developed to determine the impact of SO₂ on the physiological state of the microorganism. Strains F3 and B1b, previously isolated from Washington wines, were inoculated into Syrah wines with different concentrations of molecular SO₂ added on day 12. Viabilities (standard plating methods and fluorescence microscopy) and decreases in the concentration of molecular SO₂ were monitored. Similar to strain F3, the population of B1b as determined by plating decreased from >10⁶ cfu/mL to <250 cfu/mL after addition of 0.53 or 0.89 mg/L molecular SO₂. Although cells were not detected using plating methods, B1b remained viable and exhibited metabolic activity as evidenced by fluorescence microscopy. This finding supports the contention that *Brettanomyces* can enter a "viable-but-not-culturable" state upon exposure to SO₂. After SO₂ addition, the strain was noted to be physically much smaller, ~30 to 50% of original cell volume. Eventually, F3 and B1b regained culturability (i.e., growth on a nonselective microbiological medium).

* indicates corresponding author

Determination of the Role of Fruit Maturity in the Sensory Properties of Cabernet Sauvignon Wines

Kirsten Skogerson, Jean Dodson, Kevin Scott, and Hildegard Heymann*

Department of Viticulture and Enology, University of California, Davis, CA 95616
[hheyman@ucdavis.edu]

The inadequate understanding of grape maturity and its impact on wine flavor hampers prudent harvest decisions and has been the source of recent tension between growers and wineries. If there is an optimal time to harvest grapes from a wine sensory perspective, it is important to clarify the reason for that optimum and, if possible, the relationship between optimal harvest timing and objective analyses of fruit maturity. In this investigation into the effects of grape maturity at harvest on wine flavor, Cabernet Sauvignon berries were harvested from a single vineyard at six time-points over a 10-week period (September to November 2006) encompassing early- to late-harvest maturity levels (22 to 30 Brix). These grapes and the wines prepared from them were analyzed using descriptive analysis techniques to investigate relationships between grape sensory attributes and fruit maturity, and wine sensory attributes and fruit maturity. Chemical composition of the wines was determined using untargeted mass spectrometry techniques. Results were determined from multivariate statistical analysis correlating sensory and chemical data, and chemistries that may be key markers of sensory properties were identified.

Key Constituents Affecting Wine Body: Exploratory Study in Table Wines

Ron C. Runnebaum, Roger B. Boulton, and Hildegard Heymann*

Department of Viticulture and Enology, University of California, Davis, CA 95616
[hheyman@ucdavis.edu]

An opportunity exists to improve the industry's understanding of wine body and the chemical and physical properties of wine that influence this consumer perception. Previous work has not yet determined how individual constituents interact and combine to create the overall viscosity or body of a wine. This research used multivariate statistical modeling to identify significant correlations of several chemical and physical properties of wine with its perceived body. Seventeen white wines that span an anecdotal range of perceived viscous mouthfeel, including Chardonnay, Viognier, Pinot gris, Riesling, and Sauvignon blancs, were assessed using a descriptive analysis technique to determine quantitative ratings of viscous mouthfeel. These wines were also submitted to a wide range of chemical and physical property analyses, including capillary viscosity, density, ethanol by volume, total phenolics, organic acids (lactate, citrate, tartrate, malate, succinate), glycerol, sugars (fructose and glucose), total extract, and several inorganic cations/anions (K, Ca, Mg, Na, Cl). A multivariate statistical model has been developed that shows the viscous mouthfeel of these white wines is significantly correlated with physical properties, such as capillary viscosity and osmotic potential, and chemical properties, such as succinate, lactate, fructose, glucose, and total extract. This work also confirms previous results from other researchers indicating that ethanol and glycerol do not play an important role in viscous mouthfeel.

Molecular and Genetic Approaches to Optimize Breeding of Fanleaf Resistant Rootstocks

Brady Smith and Andrew Walker*

Department of Viticulture and Enology, University of California, Davis, CA 95616
[awalker@ucdavis.edu]

Grapevine fanleaf virus (GFLV) causes fanleaf degeneration, one of the severe viral diseases of grape. The most damaging symptom of this disease is the 20 to 80% reduction in fruit set on infected scions. The *Vitis vinifera* x *Muscadinia rotundifolia* (VR) hybrid rootstock O39-16 has been used for over 15 years to control fanleaf. Despite its questionable long-term phylloxera resistance (because of its *V. vinifera* parentage) and tendency to promote excessive scion vigor, O39-16 remains the only recommended rootstock for fanleaf sites. Rootstock trials with O39-16 have demonstrated that although it is resistant to *Xiphinema index*, the nematode vector of GFLV, the probing habit of this dagger nematode allows GFLV to be moved to the xylem, where it moves freely to the scion. However, disease symptoms are not expressed. Our work suggests that this induced tolerance is controlled by a graft-transmissible signal that originates in the O39-16 roots. We are developing a framework genetic linkage map of the VR hybrids on which to link genetic markers to compounds, from mass spectrometry results of xylem sap analysis, to this induced fanleaf tolerance. We are field-testing populations of non-*vinifera* *Vitis* spp. x *M. rotundifolia* selections for their ability to induce fanleaf tolerance. Field trials, combined with molecular genetic approaches, should lead to a greater understanding of the mechanism of induced tolerance, while generating molecular markers to facilitate future breeding of VM hybrid rootstock.

Pathogenicity, Biology, and Epidemiology of *Botryosphaeria* of Grapevines in California

José Ramón Úrbez-Torres* and W. Douglas Gubler

Department of Plant Pathology, University of California, Davis, CA 95616
[jrurbez@ucdavis.edu]

Grapevine decline caused by *Botryosphaeria* species and *Eutypa lata* results in significant economic losses to the wine industry in California. Disease symptoms include dead spurs and cordon and trunk dieback due to canker formation in the vascular tissue. Field surveys conducted in the last three years have revealed that at least nine different species of *Botryosphaeria* are widely associated with grapevine cankers in California and they appear to constitute the main group of pathogens isolated from grapevine wood cankers in other important grapegrowing areas of the United States and northern Mexico. In vivo and in vitro pathogenicity tests have revealed all nine *Botryosphaeria* species to be important pathogens of wine and table grape cultivars in California. However, virulence differed by species. *Botryosphaeria rhodina* was shown to be the most virulent species and was capable of rapidly infecting both secondary wood and green tissue. Temperature studies for mycelial growth and pycnidial formation have shown different optimum temperature regimes among *Botryosphaeria* species found in California. Preliminary results of spore-trapping studies have

shown that *Botryosphaeria* spores were mainly trapped following rainfall events or overhead sprinkler irrigation. *Botryosphaeria* spores were also trapped in some locations in the absence of rainfall or irrigation, suggesting that other environmental factors may contribute to spore release. These findings indicate the importance of *Botryosphaeria* species as grapevine pathogens and will contribute to the development of acceptable control methods.

Performance of Virus-Infected Cabernet Sauvignon Accessions Compared to Healthy Vines of the Same Source

James A. Wolpert,* Michael M. Anderson, Sue Sim, M. Jason Benz, and Deborah A. Golino

Department of Viticulture and Enology, University of California, Davis, CA 95616
[jwolpert@ucdavis.edu]

Three accessions of Cabernet Sauvignon were selected, one from each of three Napa Valley vineyards: Niebaum-Coppola (NC), Silverado Vineyards (SV), and Robert Mondavi (RM). At Foundation Plant Services (FPS), UC Davis, these selections were all treated by meristem shoot-tip culture (STC) to eliminate virus and became, respectively, FPS 29, FPS 30, and FPS 31. In spring 2002, six treatments were established: the three original, virus-infected accessions (NC, SV, and RM) and the respective STC selections FPS 29, 30 and 31. The vineyard was planted at the UC Davis Oakville Station Vineyards, Napa Valley, on 101-14 Mgt rootstock, at a spacing of 2 m x 1.5 m (row x vine), trained on a vertical shoot-positioned trellis and cordon pruned (12 shoots/m). Data were taken in 2005 and 2006. FPS 29 yielded almost twice as much crop and had a 4.0 Brix increase over the original NC selection. FPS 30 did not differ in yield from the SV selection, but had a 2.8 Brix increase. FPS 31 had 40% more yield and a 5.0 Brix increase over the RM selection. Cluster number and berries per cluster were best correlated with the yield differences.

Demonstration of Berry Shriveling Transmission by Chip Budding

Mark Krasnow,* Mark Matthews, and Ken Shackel

Department of Viticulture and Enology, University of California, Davis, CA 95616
[mnkrasnow@ucdavis.edu]

Berry shrivel (BS) is a ripening disorder that is not uncommon in vineyards of the North Coast of California. The disorder is marked by poor sugar accumulation, poor color in red varieties, and visible shriveling of the berries. The fruit from BS clusters is usually dropped in the vineyard prior to harvest at a significant cost to growers. Berry shrivel fruit exhibits differences in sugar, anthocyanins, and malate compared with healthy fruit, several weeks before visible symptoms (shrivel) become apparent. In 2003, duplicate chip buds were taken from five vines that historically exhibited BS symptoms (BS wood sources) as well as five vines that did not exhibit such symptoms (healthy wood sources), and budded onto healthy rootstock. In 2006, shortly after budbreak, vines from BS wood sources exhibited shorter shoots than vines propagated from healthy sources. Brix was consistently lower in the vines from BS wood sources than vines from healthy sources at three different sampling times approaching harvest, and at

Vine Pest Management Session, Thursday

harvest, BS vines had smaller berries than control vines. These data indicate that the BS disorder can be propagated by chip buds, suggesting either an epigenetic effect or a pathogen as the cause of the visible and compositional differences of BS fruit.

Influence of Vintage, Site, and Vine Vigor on Pinot noir Grape Anthocyanins and Proanthocyanidins

Jessica M. Cortell*, Timothy L. Righetti, and James A. Kennedy

Department of Horticulture, Oregon State University, Corvallis, OR 97331

[cortellj@onid.orst.edu]

The influence of vintage, site, and vine vigor on flavonoid accumulation in fruit and wine was determined. The specific hypothesis was that zones within the vineyard with reduced vine vigor would produce fruit with higher levels of phenolics in the fruit and wine. A second hypothesis was that differences in vintage, site, and vine vigor could produce shifts in enzyme activity in the flavonoid pathway resulting in differences in phenolic composition. Total accumulation can be influenced indirectly by berry size or directly by increased flavonoid biosynthesis. Variations in flavonoid composition (calculated as a ratio or percent of total) can be an indirect statistical artifact related to total accumulation or could be a direct effect of increased biosynthesis. Vine vigor parameters were used to designate zones within two vineyard sites to study differences in fruit and wine flavonoid chemistry. There were large differences between vintages for skin proanthocyanidin and anthocyanins. All ratio-based expressions mathematically scale (dependent on differences in denominator size) if a plot of the denominator versus the numerator has a nonzero y-intercept. Different interpretations resulted when percent composition and regression analyses that account for scaling effects were used. This scaling effect can create significant effects that are an artifact or mask real effects. Different interpretations of the data may occur when scaling is either ignored or accounted for in data analyses. A complete analysis can provide better insight into regulation of the flavonoid biosynthetic pathway.

Competition Reactions of Hydrogen Peroxide with Iron (II) and Sulfite in Model Wine Solution

Ryan J. Elias* and Andrew L. Waterhouse

Department of Viticulture and Enology, University of California, Davis, CA 95616

[relias@ucdavis.edu]

This study addressed the competition for hydrogen peroxide between iron and sulfite in model wine solution. Recent findings suggest that transition metal catalysis plays a central role in wine oxidation. Ferric ions (Fe^{3+}) catalyze the oxidation of polyphenols present in wine in an oxygen-consuming process, ultimately yielding quinones and hydrogen peroxide. We hypothesized that the reduced ferrous ions (Fe^{2+}) that result from this reaction subsequently catalyze the reduction of hydrogen peroxide via the Fenton reaction to form hydroxyl radicals. These radicals are extremely potent oxidants that can react with almost all wine components, in proportion to their concentration, and independently of the wine's pool of endogenous antioxidants. Recent studies have demonstrated that Fenton products affect wine quality. Hydrogen peroxide has also been shown to react rapidly with bisulfite at low pH to yield sulfate, and thus competes with the Fenton reaction in wine. Under inert nitrogen gas, hydroxyl radicals react with ethanol to yield acetaldehyde, serving as evidence of the Fenton reaction. Fol-

lowing acetaldehyde formation in model wine allowed us to determine which reaction dominates at given concentrations of Fenton reagents and sulfur dioxide. Loss of hydrogen peroxide and sulfite, as well as changes in $\text{Fe}^{2+}/\text{Fe}^{3+}$ concentrations, were also followed to help elucidate mechanistic details of the competing reactions. A fundamental understanding of these chemical pathways will lead to new tools for predicting and controlling the outcome of wine oxidation.

Variation in the Phenolic Composition of California Pinot noir Fruit and Wines

Thomas M. Fitzpatrick and Douglas O. Adams*

Department of Viticulture and Enology, University of California, Davis, CA 95616
[doadams@ucdavis.edu]

Although several groups have studied the phenolic composition of various cultivars grown on single sites, few have focused on uncovering the nature and limits of phenolic expression within a single cultivar when grown on many sites. This study was undertaken to characterize the phenolic variation of Pinot noir fruit and wines when grown within a number of diverse sites and to determine how much of this variation could be explained by various vineyard variables. We measured total phenolics, tannin, anthocyanin, large polymeric pigment, and small polymeric pigment in the skins and seeds of four different clones of Pinot noir, on four different rootstocks, grown on 48 diverse sites throughout California and in the press wines from this fruit. The variation in phenolic concentrations was large. Although wine phenolic concentrations varied most, skins had significantly more phenolic variation than seeds, signifying their susceptibility to environmental influence. Although far less variable, seeds contained over 10 times the concentration of total phenolics and tannin found in skins. Within the skins, tannin and anthocyanin concentrations varied significantly more than total phenolic concentrations, indicating that the phenolics pool must be compensating. With few exceptions, the distributions of phenolic concentrations in skins/seeds for the four different clones were surprisingly similar, indicating that much of the observed phenolic variation must be environmentally induced. Among the effects of clone, rootstock, training/pruning method, spacing, and vine age, only rootstock appeared to influence tannin concentration. However, several had some influence on skin anthocyanin and skin/seed total phenolic concentrations.

Formation of Polymeric Pigments in Wine with a Low Ratio of Tannin to Anthocyanin

Karl L. Wilker* and Jing Zhang

Department of Agriculture, Missouri State University, Mountain Grove, MO 65711
[KarlWilker@missouristate.edu]

Tannin to anthocyanin ratios >1 are considered necessary for proper color stabilization in aged red wines. Lower ratios favor the formation of small polymeric pigments over large polymeric pigments. Wines made from Norton grapes (*Vitis aestivalis*) tend to have tannin to anthocyanin ratios <1 . An experiment was conducted to study the effects of adding commercial grape seed tannin (increasing

the tannin to anthocyanin ratio) on polymeric pigment formation in Norton wine. One treatment increased the tannin to anthocyanin ratio by adding tannin (1000 mg/L) at the start of fermentation. A second treatment consisted of the same tannin addition after pressing. Wine made without the addition of tannin was used as a control. The wines were fermented in 10-gallon tanks with covers. Tannin additions after pressing resulted in higher levels of large polymeric pigment. Tannin additions at the start of fermentation initially resulted in lower levels of small polymeric pigments. However, these differences did not continue during aging. Higher tannin levels were achieved by adding tannin after pressing rather than at fermentation.

Assessment of Fruit Tannin and Tannin-Binding Capacity of Berry Cell Walls from Pinot noir by Clonal Selection and Site

Robert C. Scholz and Douglas O. Adams*

Department of Viticulture and Enology, University of California, Davis, CA 95616

[doadams@ucdavis.edu]

Tannin extraction has been traditionally understood as being subject to solubility and diffusion kinetics; however, recent research has shown that the insoluble matrix of skin and mesocarp grape berry cell wall material (CWM) can bind significant amounts of fruit tannin, between 25 and 75% of the total fruit tannin in Cabernet Sauvignon. Since tannin is central to red wine color stability and associated with quality and balance, understanding how the insoluble CWM influences tannin extraction from fruit is critical. Fruit from three Pinot noir clones were obtained at commercial harvest from four different sites in California. Skin and mesocarp CWM were prepared by removing phenolic compounds with 70% acetone and then grinding to a fine suspension. The washed CWM was assayed for tannin-binding capacity using a standard tannin solution made from Cabernet Sauvignon skin tannin. Skin CWM accounted for two-thirds of the total cell wall mass; however, the binding capacity of mesocarp CWM was slightly higher than skin, with greater variation among sites than among clones. The combined binding capacity for mesocarp and skin CWM ranged from 25 to 30 μg tannin/mg CWM, indicating the potential binding of 40 to 60% of the total fruit tannin. Tannin in seeds and skin was measured by protein precipitation. The amount of skin tannin per berry showed less variation across site and clone, while seed tannin levels showed greater variation among sites. These results suggest that site plays a greater role than clone in determining tanning-binding capacity and total fruit tannin levels.

Access the American Journal of Enology and Viticulture Online

- Current journal issues available as full-text HTML and PDF
- Complete archives (1950–2004) available in PDF format
- Advanced search tools for key words, topics, and authors
- Free abstracts and table of contents alerts
- In-text reference links
- ISI Web of Science links
- Citation manager



Full online access is a benefit for all ASEV members.

Institutional subscriptions are available for full access, including archives.

Individual articles available on a pay-per-view basis.

Also on the site is the AJEV Guide to Authors, which includes sections on submitting manuscripts, reporting winemaking studies (including reproducibility), and reporting sensory evaluation conditions.

Access the free sample issue on the home page.

www.ajevonline.org



American Society for Enology and Viticulture
PO Box 1855
Davis, CA 95617-1855 USA
Tel: 530 753-3142 Fax: 530 753-3318
Email: society@asev.org Website: www.asev.org