Challenges and Opportunities in a Changing Climate

Winemaking & Global Warming

Christian E. Butzke
2nd Vice President ASEV
Enology Professor
Purdue University

butzke@purdue.edu 1.765.494.6500 enology.butzke.com
Outline

- Vintage-to-Vintage variation
- Flexibility in practices/regulations
- Grape/must temperature
- Yeast nutrient content
- Ripeness assessment
- Color extraction/Copigmentation
- (Seed) tannin extraction
- Alcohol/aroma adjustments
- Aging/shipping temperatures
South Africa
King of Prussia
Wine Quality

Grapes: 75%
Equipment: 10%
Barrels: 10%
Winemaker: 5%

Thomas Eddy, 2000
In: Wine Marketing
University Press
Latitude Comparison

France

42°

CA
IN
PA

South Africa

32°
Latitude Comparison

CA

IN

PA

Iberia

42°

32°
Regional Warming/Cooling
Annual Temperature Fluctuation

Oakville, Napa Valley

T (°F)

J J F M A M J J A S O N D

6C
Degree Days (55°F) vs. Wine Quality Scores
Artificial Neural Networks

Viticulture

Grape Juice Characteristics
Yeast/Bacteria Characteristics
Processing Parameters

Fermentation Kinetics
Chemical Analysis
Sensory Analysis

Clone
Rootstock
Weather
Soil Type
Vine Spacing
Irrigation
Fertilizer
Pest Control
Yield
Management

Dr. David Block
UC Davis
Grape Growing Conditions and Vintage Quality Scores

Neural Network Fit

Model Fit

\[ R = 0.77 \]  
\[ (p < 0.001) \]

Predicted and actual values for Napa Cabernet Sauvignon Quality

- - - Actual Quality
- - - ANN Prediction

Quality Score


Vintage Year

D. Block, UC Davis
Flexible Practices/Regulations

- Irrigation
- Varietals
- Aging Requirements
Vineyard/Varietal Match

Full color/tannin ripeness

Ripening too early

Ideal ripening

Ripening too late

Full aroma ripeness

Color change

Time

Y. Glories 1986

Fig. 6.39. Variations in the accumulation of anthocyanins in grape skins during ripening, according to vintages and vineyards. For the same vintage: 1, ideal situation, good grape–vineyard match; 2, late-ripening vineyard requiring slight overripeness; 3, very late-ripening vineyard, where the grapes are unlikely to produce a high-quality red wine; 4, Vineyard not very well-suited to this grape variety, as phenolic maturity occurs too early (Glories, 1986)
Ripeness Variation/Assessment
Ripeness Variation

@ Veraison = @ Harvest

R. Boulton, UC Davis
Brix
- 20.0 - 21.1
- 21.1 - 22.1
- 22.1 - 23.0
- 23.0 - 24.9

Range: 20.0 - 24.9
Mean: 22.1 +/- 0.9

Ripeness Variation

R. Boulton, UC Davis
Fruit/Must Chilling
Skin Contact Time = f (Temperature)
Yeast Available Nitrogen Content

Variation by Varietal and Region

Ammonium Nitrogen (mg/L)

\[ \text{NH}_4^+ \]

\[ R^2 = 0.09 \]

Yeast Assimilable Amino Nitrogen (mg/L)

Amino
Yeast Available Nitrogen Content
Deficiency Variation by Varietal

Juices < 140 mg N/L (%)

- Pinot noir
- Zinfandel
- Merlot
- Cabernet Sauvignon
- Cabernet franc
- Chardonnay
- Sauvignon blanc
Nitrogen & élevage sur lies

Fermentation Temperature = f (Fermentation Rate)
Fermentation Rate = f (Yeast Available Nitrogen)

Lees => Mannoproteins = f (Yeast Available Nitrogen)!
New Diseases?

Glassy Winged Sharp Shooter

*Xylella fastidiosa* (bacterium)

Pierce’s Disease → Dying Grapevines
Wine and Regional Cooling
Annual Precipitation
Average Regional Variation

San Francisco, USA
New England, USA
Burgundy
Bordeaux
Cape Town
Gulf Stream Effect
Precipitation Variation

Long Island, New York

October rain:
Average 94 mm

2005
305 mm

Gulf Stream
Rain at Harvest

- No sun
- Water on clusters
- Water in soil
- Berry splitting
- High humidity

Suspended ripening
Dilution, Rot
Dilution
Rot
Rot
Cold Maceration/Fermentation Timing

Skin Contact Time = f (Temperature)
Red Wine Color

Extraction vs. Stability

Anthocyanins

Berry:
100% in skin
0% in seeds
0% in pulp

Wine:
25% Cabernet
15% Pinot Noir
Copigmentation

Anthocyanin

Cofactor

Anthocyanin

Copigment Stack
Color and Cofermentation

Pinot Noir/Pinot ?
Syrah/Viognier ?
Sangiovese/Trebbiano ?
Cap Management Technique
Does it matter?
Anthocyanin vs. Tannin Extraction

Anthocyanins (g/L)

Tannins (g/L/6.25)

Skin contact time (days)
Seed Number per Berry

Variation/Ripeness = f (Vintage)
“Maceration of wine on the pomace after fermentation is through, increases tannin but adds nothing to color.”

Prof. Eugene Hilgard
University of California
Berkeley, 1887
Polymeric Color

HPLC Absorbance

- Monterey
- Sonoma
- Paso Robles
- Lodi

- Heat at the End
- Rotary/Enzyme
- Extended Maceration
- Oak Tannins
- Control

A. Waterhouse
Maceration = f (Temperature)
Extraction and Temperature

Extractable Phenolics (%)

Skin Contact Time (hours)

30°C
20°C
10°C

Temperature
Extraction and Alcohol

Extractable Phenolics (%)

Skin Contact Time (hours)

Ethanol (%vol)

- 14
- 11
- 8
- 4
- 2
- 0
Dehydration, Sugar and Alcohol

Shiraz Shrivel
Alcohol Removal?

Reverse Osmosis

No absolute cut-off!

smallest

pore size (nm)

largest
Reverse Osmosis
Aroma Removal

Molecular Weights:

- Ethyldecadienoate: 196
- Oak Lactone: 156
- Vanillin: 152
- 4-Ethylphenol: 122
- 2-Phenylethanol: 122
- Methoxypyrazine: 110
- Ethylacetate: 88
- Diacetyl: 86
- Molecular SO₂: 64
- Acetic acid: 60
- Ethanol: 46
- CO₂: 44
- Water: 18
Wine Shipping Heat Exposure en Route

Temperature (°F)
Wine Shipping
Container Position

Temperature (°F)

Top
Tail
Nose

Wine Shipping Container Position
Barrel/Bottle Aging Reactions

Doubling of Rate

O₂ uptake: 3.8°C
(Ribereau-Gayon 1933)

Browning: 7.8°C
(Berg & Akiyoshi 1956)

SO₂ decline (w): 37°C
(Ough 1985)

EC formation: 16°C
(CEB 2001)
Winemaking Advice

- Always question your traditions
- Be flexible with vineyard/wine regulations
- Watch similar international regions
- Invest money in wine and grape research
- Extend and use scientific information
- Be out in the vineyard
- Cold-store wines for comparison
Winemaking Advice

- Save money to replant, buy equipment
- Be pro-active - don’t wait too long
- Watch your yeast nutrient status
- Don’t over-extract before/after fermentation
- Measure your seed numbers
- Don’t believe in miracle cures/equipment
- Use intuition and intellect
Wine Quality

- Grapes: 75% = Climate!
- Equipment: 10%
- Barrels: 10%
- Winemaker: 5%
Positive proof of global warming.
5th Joint Burgundy-California-Oregon Winemaking Symposium

Portland OR
June 17th
Winter Blues?
The Wine Grape Action Team is a cooperation between Purdue University's Department of Food Science and the Indiana Wine Grape Council to serve the State's vintners and growers and help propel the Indiana wine/grape industry into world-class competitiveness. The 4-member team is available at any time to troubleshoot emerging issues in your vineyard and winery.

- 2008 Spring Grape and Wine Workshop - **Wednesday, March 19**
  - Host: Oliver Winery
  - Program & Registration (Jill Blume)

- 2008 Italy for Wine Professionals
  - Program May 10-10 (Christian Butzke, Bruce Bordelon & Jill Blume)
  - Registration

- 2008 Wineries Unlimited
  - Program (March 4-7, King of Prussia, PA)
  - Registration

- 2008 Michigan Wine Industry Annual Meeting
  - Program (February 28, Crystal Mountain Resort, Thompsonville, MI)
  - Wine Filtration Workshop (Christian Butzke)
Enology Session

Enzymes

Sigrid Gertsen-Briand & Christian Butzke