Wine Chemistry: A Sensory Perspective

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American Chemical Society Meeting
Division of Chemical Information Luncheon
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• Grapes
• Fermentation
• Aging
• Sensory
• Health
A High Quality Draft Consensus Sequence of the Genome of a Heterozygous Grapevine Variety

Genetic linkage maps of two interspecific grape crosses (Vitis spp.) used to localize quantitative trait loci for downy mildew resistance

Transcriptomic and metabolite analyses of Cabernet Sauvignon grape berry development
Laurent G Deluc1, Jérôme Grimplet1, Matthew D Wheatley1,
Richard L Tillett1, David R Quilici1, Craig Osborne2, David A Schooley1,
Karen A Schlauch3, John C Cushman1 and Grant R Cramer*1

VitisNet: "Omics" Integration through Grapevine Molecular Networks


For Kirsten Skogerson at the University of California, Davis, wondering about how chemical and gas chromatography-mass spectrometry (GC-MS), they looked at 17 different white rade range of body, analysis, they first alcohol under reduced open ran samples upon GC-TOF analysing the from the BinBase program in John's lab. Each directly analysed on a Bruker Daltonics 600 mHz NMR instrument with the resulting
Chemical Composition

- Water (85%)
- "Everything Else" (12%)
- Glycerol (3%)

"Everything Else" includes:
- Phenolics
- Minerals
- Sugars
- Amino acids
- Higher alcohols
- Volatile acidity
- Sugar alcohols
- Sulfites
- Esters

Prof. Andy Waterhouse, Dept Viticulture & Enology, UC Davis
• Tasting exercise
• Wine aroma wheel
• Wine glass shape
• Wine “body”
• Wine and food pairing
• Wine bottle closures
Sterling Vintners Label

2010 Sauvignon Blanc
2009 Cabernet Sauvignon
• **Sauvignon Blanc**
  – Aromatic white
  – ‘white’ Bordeaux
    - Apple, peach, citrus, oak
  – New-world style
    - Grapefruit, passion fruit, ‘cat pee’

• **Cabernet Sauvignon**
  – Cab Franc x Sauvignon Blanc
  – 3rd largest production in CA after Chardonnay and . . . ?
  – Black currant & bell pepper
How do you describe the wines?

...tropical fruit abounds with pretty aromas of passion fruit and orange peel. ...flashes of citrus grace the warm, tropical guava and honeydew. ...bright acidity balanced with weight and depth. Characteristic notes of fresh-cut grass carry throughout the palate, which finishes with a crisp snap of lime.

...ripe, rich character with elegance and poise. Black berry fruit and ripe cherries...toasty vanilla and cocoa. Full and fleshy...balanced by good acidity and bright cherry notes. Smooth tannins cradle the finish, integrating subtle elements of oak and spice.

tasting notes from Sterling Vineyards
Wine Aroma Wheel

Professor
Ann Noble
UC Davis

Start in the middle and work your way out...
Start in the middle and work your way out...

Vegetative
But wine is made from grapes…

3-isobutyl-2-methoxypyrazine

cis-rose oxide

rotundone

methyl butanoate
ethyl butanoate
ethyl hexanoate
β-damascenone

isoamyl-acetate
...but I can’t smell that!

- Practice
- Subjective
- Nasal enzymes

- Anosmia (inability to perceive odors)
Does glass shape matter?

“To fully appreciate the different grape varieties and the subtle characteristics of individual wines, it is essential to have a glass which has a shape fine-tuned for the purpose” — Riedel marketing

- 2 varieties, 5 glasses, 3 equilibration times
- Some shapes intensify aroma compounds in glass headspace
- Glass with highest headspace concentration showed lowest total aroma intensity
- No significant differences in sensory profile

Hirson, G. D., M.S. Thesis, University of California, Davis, 2009
What is wine body?

• Mouthfeel viscosity
• Full → medium → light-bodied → watery
• What compounds contribute to ‘body’?
  – Ethanol, Sugars, Glycerol
  – Grape-derived or yeast-derived metabolites
  – ??????
• How can viticulture and/or enology practices be fine-tuned to alter mouthfeel?
• GC-MS and NMR-based metabolite profiling

• 17 white wines, 6 varieties, 7 regions, 10 panelists

• Multivariate statistics to correlate metabolite and sensory data

• **Proline positively correlated**
  – One of most abundant amino acids in must/wine
  – Unusual solution properties
  – Increasing concentration yields exponential increase in solution viscosity

• **Organic acids / fatty acids negatively correlated**

• **Follow-up studies needed**

  grape maturity, variety, soil type, rootstock, fertilization, crop level, yeast strain, skin contact, fermentation temperatures, aging practices

Food & wine pairing*

- Basic tastes
  - sweet, sour, salty, bitter, umami

- Wine tastes
  - sweet, sour, bitter

- Wine changes predictably with food:
  - Sweet / umami foods emphasize wine tastes
  - Sour / salty foods soften wine tastes

Don’t worry about the rules!
Drink the wines you like with the food you like.

* Tim Hanni, MW
Wine & cheese – the perfect pairing?

- Good pairing = both enhance each other
- Trained panel tasted wines before and after sampling cheese . . .

All wine attributes diminished after eating cheese

If you want to enjoy the wine– do not serve it with cheese.

Wine bottle closures
• ‘cork taint’ (TCA)
  – ppt sensory threshold
  – “musty”, “moldy”, “earthy”, “muddy”
  – muted fruit aromas
  – 2, 5, 7 . . . 25% ?

• Consumer preference
• Winery issues
  – Systemic TCA
    • drain pipes, hoses, wood structures can become contaminated
  – Solutions
    • replace chlorinated cleaning agents with peroxide/peracetic alternatives
    • build new facility (remove wood treated with TCP)

• Screw cap aroma taints
• Shipping / handling
• Conditions unregulated
• Temperature fluctuations increase $O_2$ ingress

AWRI study

- Semillon wine
- 14 closures
  - screw cap
  - plastic corks
  - composite corks
  - natural cork
- Temperature-controlled storage

Closure debate – *the real issues*

- **Natural cork**
  - Tradition
  - Natural variation = wine variation….
  - Not the only source of corkiness

- **Plastic corks**
  - Seal inside bottle
  - Material science research needed!!

- **Screw cap**
  - Best sensory performance in AWRI study
  - Seal outside bottle
  - Least ‘forgiving’ of the closures
Is unfiltered wine better than filtered wine?
Should I decant wines before serving?

Do old vines produce better wines?

Why is Viognier (white grape) vinified with Syrah (red grape) in the Rhone?

What do I do with the cork at a restaurant?

NEW OAK? FRENCH OAK? AMERICAN OAK?

What is terrior?

Why does this wine smell like sweaty socks?
Is a $100 bottle ten times better than a $10 bottle?

What is co-pigmentation?