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The Influence of Alcohol on Wine Sensory Profiles

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Studying alcohol effects in wine

- Manipulate alcohol concentrations pre-fermentation – variable harvesting
- Study commercial wines with varying alcohol levels
- Manipulate alcohol concentrations post-fermentation – dealcoholization

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Objectives:

To determine the influence of alcohol on the sensory perception of US Cabernet Sauvignon wines

To investigate whether tasting order affects perception of red wines with varying levels of alcohol

The influence of alcohol on the sensory perception of red wines

1. King, E.S., Dunn, R., and Heymann, H.. (2013) The influence of alcohol on the sensory perception of red wines. Food Quality and Preference 28, 235-243.
2. Hjelmeland, A.K., King, E.S., Ebeler, S.E., and Heymann, H. (2013) Characterizing the chemical & sensory profiles of commercial US Cabernet Sauvignon wines. American. Journal of Enology and Viticulture 64, 169-179.

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Methodology – Wines

- 24 commercial Cabernet Sauvignon wines
  - California – Napa Valley, Sonoma County, Lodi, Paso Robles
  - Washington State – Columbia Valley
- 2000 – 2009
- US $3 – $125
- Natural or synthetic cork closure
- 12 – 16 %v/v

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Methodology – Alcohol groups

12 – 16 %v/v

LOW alcohol
< 14 %v/v
8 wines

HIGH alcohol
> 14 %v/v
16 wines

L1 – L8

H9 – H24

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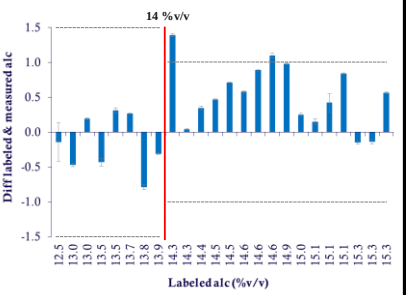
Labeled alcohol levels

- 24 commercial US Cabernet Sauvignon wines
- Anton Parr NIR Alcolyzer
- 2 time points (4 months apart)
- 2 bottle x 3 replicates



"We observe systematic patterns in the errors: …a tendency to understate the alcohol content for wine that has relatively high alcohol content." **(Alston et al. 2011)**

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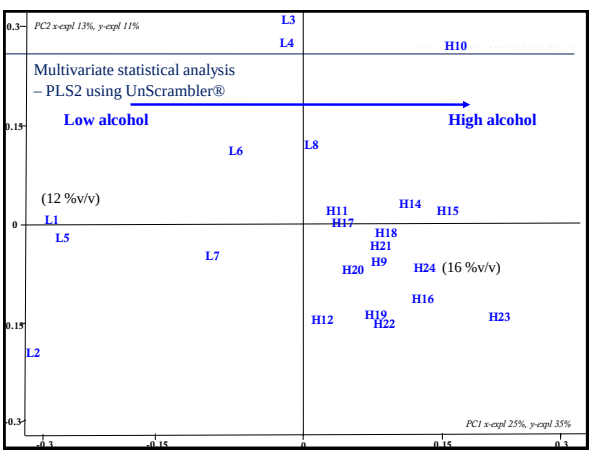
Methodology – Descriptive analysis

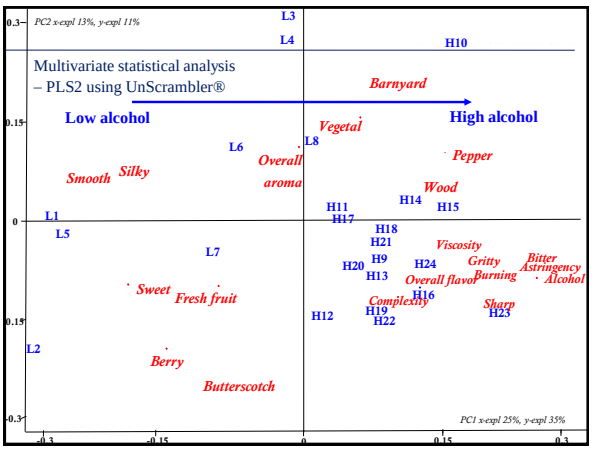
Descriptive sensory analysis
– 11 trained panelists

RANDOM

Low alcohol (<14 %v/v)

High alcohol (>14 %v/v)





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Results – Influence of alcohol

Appearance

- Red
- Purple
- Brown
- Orange
- Pink
- Clarity
- Viscosity/ legs

Aroma

- Overall aroma intensity
- Fresh fruit
- Dark fruit
- Berry
- Dried fruit
- Floral
- Honey
- Wood
- Spice
- Pepper
- Vegetal
- Herbal
- Mint
- Sulfur
- Earthy
- Barnyard
- Alcohol
- Vinegar
- Chemical
- Burning

Flavor

- Overall flavor intensity
- Sourness
- Sweetness
- Bitterness
- Alcohol
- Viscosity
- Complexity
- Astringency
- Smoothness
- Silkiness
- Sharpness
- Grittiness
- Length of flavor
- Burning

+ve relationship

-ve relationship

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Conclusions – Influence of alcohol

- Commercial US Cabernet wines were differentiated as a result of the direct and indirect influence of varying alcohol levels.
- **High alcohol wines**, in general, are higher in:
  - Alcohol aroma & flavor
  - Chemical aroma
  - Burning aroma & mouthfeel
  - Overall flavor
  - Bitter taste
  - Viscosity
  - Hot mouthfeel
- **Low alcohol wines**, in general, are higher in:
  - Fresh Fruit aroma
  - Smooth mouthfeel

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References – Influence of alcohol

- **Ethanol enhances 'bitterness'** ✓
  - Demiglio & Pickering (2008)
  - Fischer & Noble (1994)
  - Fontoin et al. (2008)
  - Jones et al. (2008)
  - Nurgel & Pickering (2006)
  - Panovska et al. (2008)
  - Scinska et al. (2000)
  - Sokolowsky & Fischer (2012)
  - Vidal et al. (2004)
- **Ethanol contributes 'hotness'** ✓
  - Gawel et al. (2007)
  - Jones et al. (2008)
  - Nurgel & Pickering (2006)
  - Williams (1972)
- **Ethanol suppresses 'fruit' aromas** ✓
  - Escudero et al. (2007)
  - Goldner et al. (2009)
- **Ethanol suppresses 'sourness'** ?
  - Williams (1972)
- **Ethanol reduces 'astringency'**
  - Fontoin et al. (2008)
  - Vidal et al. (2004)

  unless in the presence of high tannin concentrations ?
  - Obreque-Slier et al. (2010)
  - Sáenz-Navajas et al. (2010)
- **Ethanol has little or no effect on 'viscosity' or wine 'body'** ?
  - Gawel et al. (2007)
  - Nurgel & Pickering (2005)
  - Pickering et al. (1998)
  - Runnebaum et al. (2011)
- **Ethanol can alter the perception of 'sweetness'** …
  - Nurgel & Pickering (2006)
  - Panovska et al. (2008)
  - Scinska et al. (2000)

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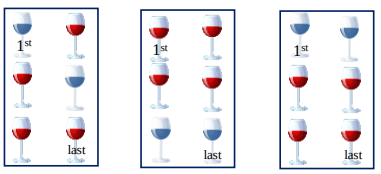
Methodology – Descriptive analysis

Descriptive sensory analysis (DA)

– 11-12 trained panelists in each order



RANDOM **HI-LO** **LO-HI**

Low alcohol (<14 %v/v) High alcohol (>14 %v/v)

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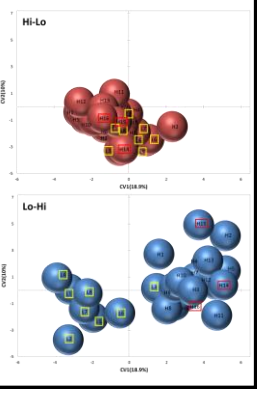
Results – Wine Order

- **Hi-Lo:**
  - when high alcohol wines were tasted first, there was less differentiation among the wines
- **Lo-Hi:**
  - when low alcohol wines are tasted first, there is more discrimination among the wines



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Summary – DA – Low alcohol wines

Hi-Lo (last)

- ↑ *honey*
- ↑ *herbal*
- ↑ *vegetal*
- ↑ *chemical*
- ↓ *smoothness*

Lo-Hi (first)

- ↑ *alcohol aroma*
- ↑ *sourness*

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Summary – DA – High alcohol wines

Hi-Lo (first)

- ↑ *bitterness*
- ↓ *grittiness*

Lo-Hi (last)

- ↑ *overall aroma*
- ↑ *honey*
- ↑ *herbal*
- ↑ *spice*
- ↑ *wood*
- ↑ *earthy*
- ↑ *chemical*
- ↑ *alcohol*
- ↑ *burning*
- ↑ *astringency*
- ↑ *complexity*
- ↑ *sweetness*
- ↑ *silkiness*
- ↑ *viscosity*
- ↑ *sharpness*

Conclusions – Wine order

- The order of wine assessment based on alcohol concentration significantly influenced sensory perception, particularly on the palate.
  - Tasting high alcohol wines first resulted in less differentiation among the high and low alcohol wines.
  - The largest differences occurred when low alcohol wines were tasted first, with dramatic enhancement of the sensory profiles of high alcohol wines.
    - Possibly due to stronger contrasting effects between low and high alcohol wines
    - Or, possibility of panelists' experiencing physical carry-over or palate fatigue

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Objectives:

To investigate the influence of dealcoholization on sensory profiles and consumer preferences

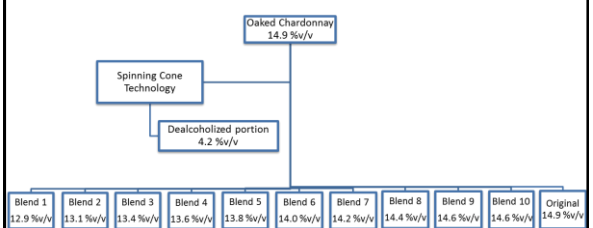
Does the wine "sweet spot" really exist?

The effect of dealcoholization on the sensory profiles and consumer preferences of white wine

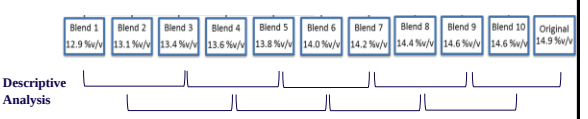
3. King & Heymann (2014) The effect of reduced alcohol on the sensory profiles and consumer preferences of white wine. Journal of Sensory Studies 29, 33-42

Methodology – Wines

- 2010 Californian oaked Chardonnay – 14.9 %v/v
- Dealcoholized using spinning cone technology to 4.2 %v/v
- Blends created at 0.2 %v/v increments up to 2 %v/v reduction (10 blends in total) from 12.9 %v/v to 14.6 %v/v.



Methodology – Descriptive Tests



- Trained panelists (n=12) rated 10 aroma and 8 taste & mouthfeel attributes.
- Minimum difference of ~0.4 %v/v between wines assessed (every 2 samples)

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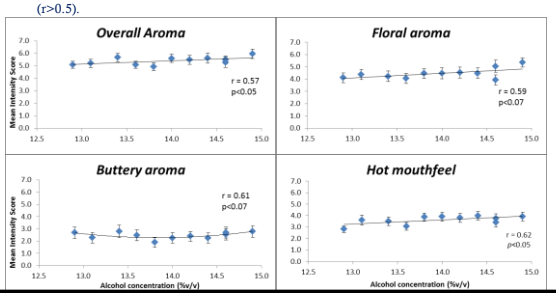
Descriptive Analysis Results

- *Overall Aroma, Floral aroma, Buttery aroma* and *Hot Mouthfeel* were significantly different among the reduced alcohol wines.
  - There were positive correlations between the intensity ratings and alcohol concentrations (r>0.5).



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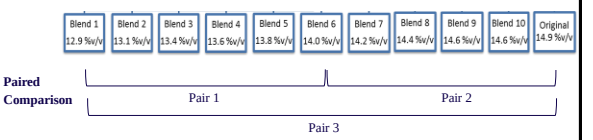
Methodology – Difference Tests



Paired Comparison

Pair 1

Pair 2

Pair 3

- Which sample is *hotter*?
- Trained panelists (n=11) with 4 replications
- Minimum difference of ~1 %v/v between wines assessed:
  - Blend 1 vs Blend 6; Blend 6 vs Original; Blend 1 vs Original

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Difference Testing Results

- Results from paired, directed difference test where trained panelists identified the sample highest in alcohol.
  - To determine whether the wines differed significantly in alcohol perception at an approximate minimum 1% v/v level, similar to the range assessed by consumers.
- For all three comparisons, panelists were correctly able to differentiate the samples based on alcohol.

Wines	Blend 1 & Blend 6	Blend 6 & Original	Blend 1 & Original
Alcohol range	12.9 – 14.0%v/v	14.0 – 14.9%v/v	12.9 – 14.9%v/v
% difference in alcohol	1.1%v/v	0.9%v/v	2%v/v
correct # responses	29 / 44 (66%)	29 / 44 (66%)	29 / 44 (66%)
p-value	0.05 ✓	0.05 ✓	0.05 ✓

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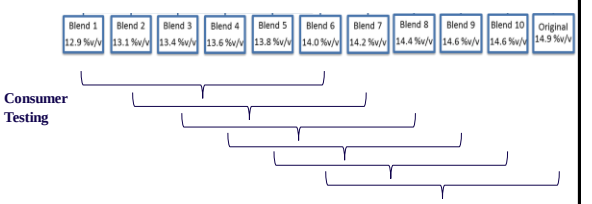
Methodology – Consumer Test

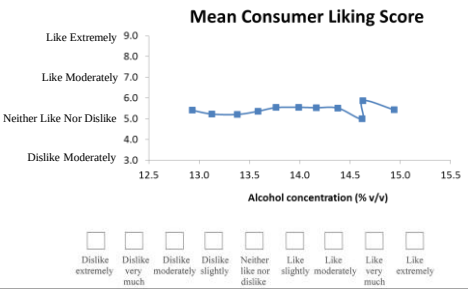


Consumer Testing

- Consumer testing (n=101)
- 6 wines spanning ~1 %v/v (16-18 consumers assessed each subset)
- Liking & sorting

Consumer Testing Results

- Overall, there was no significant difference in liking for the original Chardonnay wine and up to 1 %v/v reduced alcohol blends.



References – Influence of dealcoholization

- **Reduced perception of sweetness, red fruit, cherry, spice, persistence & strength**
  - Red wine (>1.5 %v/v reduction) (Meillon et al. 2009)
  - Syrah (>4 %v/v reduction) (Meillon et al. 2010b)
  - Aglianico (>5 %v/v reduction) (Listanti et al. 2011)
- **No difference in consumer preference**
  - Chardonnay (1.5 %v/v & 3 %v/v reduction) (Meillon et al. 2010a)
  - Syrah (2 %v/v & 4 %v/v reduction (Meillon et al. 2010b)
- **Decreased consumer liking compared to Control**
  - Chardonnay (>4.5 %v/v reduction) (Meillon et al. 2010a)
  - Syrah (>5.5 %v/v reduction) (Meillon et al. 2010b)

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Wine Alcohol "Sweet Spot"

THE CONCEPT OF 'SWEET SPOT'

Reducing alcohol in wines from high levels has exposed the unexpected phenomenon of the alcohol 'sweet spot'. In this, it is a common experience for tasters to notice that when the alcohol level in a given wine is varied by as little as + or – 0.1%, significant changes in the flavour intensity and balance occur.

Wollan (2006)

- Experienced winemakers may be able to detect subtle differences in wine sensory profiles at low concentration ranges.
- BUT, is this relevant for average consumers drinking wine under typical conditions?

http://www.conetech.com/alcohol-management/

Conclusions – Dealcoholization

- A moderate reduction of alcohol in oaked Chardonnay wines has a minimal impact on sensory composition and consumer preferences.
  - There does not seem to be any evidence of an alcohol "sweet spot" for consumers in oaked Chardonnay wine dealcoholized using spinning cone technology.
- It would be advantageous for wine producers and consumers to be better informed, regarding the financial, social and health benefits of partially dealcoholized wine, without reduction in wine quality.

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Overall Conclusions

- The results of these studies demonstrate the importance of alcohol concentrations on wine sensory profiles.
- Alcohol concentrations should be considered when determining the order for assessing wine quality.
  - Potentially incorporated in the classifications of wines during wine competitions and reviews.
- Alcohol reduction technology can be of beneficial use to the wine industry without compromising wine quality.
  - The resulting wines are not likely to greatly influence the sensory profile or consumer preference within a 2 %v/v alcohol range.
- Chaptilization of unripe fruit pre-fermentation altered the sensory profile to be more like wine made from riper fruit.
  - The addition of sugar to must (where permissible) can improve the sensory profile of unripe fruit.

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Potential reasons for the influence of alcohol of wine sensory profiles

- Alcohol itself may be contributing to the sensory profile
  - Ethanol affects the solubility and volatility of volatile compounds, and their ability to bind with proteins (Voilley and Lubbers 1999)
  - Through a masking effect (Williams 1972)
  - Decreased volatility of wine aroma compounds (Goldner et al. 2009, Robinson et al. 2009).

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Potential reasons for the influence of alcohol of wine sensory profiles – Correlative or Causal?

- Alcohol itself may be contributing to the sensory profile
- But, may also be due to...
  - Grape effects:
    - Higher sugar concentration = Riper flavors
  - Fermentation effects:
    - Higher sugar concentration = Longer fermentation
      - More fermentation-derived compounds
      - More extraction of grape-derived compounds
  - Wine style effects
    - Higher alcohol wines more likely to be oaked for longer periods

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•Cornerstone Cellars
•Frog's Leap Winery
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Alcohol… Too Much of a Good Thing?

Some wine writers express their dismay
Over high alcohol cabernet
Burning coal, says Al Gore
Not the high Parker score
Is the cause of the rising baumé

Still a 15 percent chardonnay
Will be too hot to drink most would say
Lower Brix on the vine
Spinning tricks with the wine
Or a lie on the label might pay

Alston et al. (2011)

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