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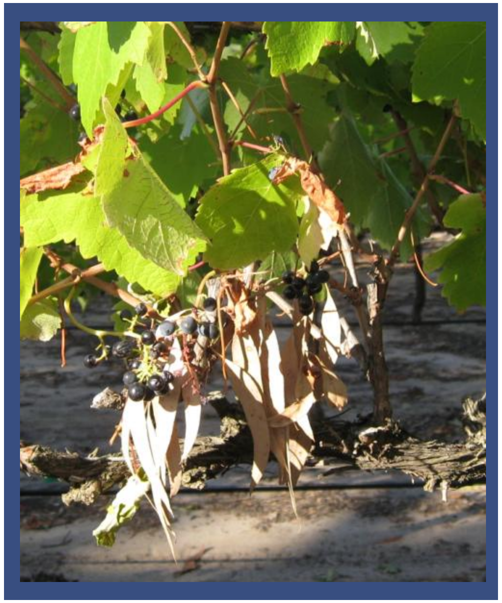
Aroma compounds important to Pinot Noir: An overview and recent ‘eucalypt/mint’ research

Dr Dimitra L. Capone



Background on Wine Aroma

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Complex with ~ 800 volatile compounds identified to date

Can be derived from numerous sources:

(either chemically or by enzymatic reactions)

- Grape berry itself: **e.g. terpenoids, MP's & C_6 compounds**
- Non volatile precursors in the grape being released during processing/storage: **e.g. varietal thiols & glycosides**
- Fermentation derived: **e.g. higher alcohols, ethyl esters & acetates**
- Oakwood contact: **e.g. oak lactones & vanillin**
- Oxidative & acid-catalysed reactions upon storage: **e.g. TDN & sotolon**
- Exogenous sources: **e.g. TCA**

Factors affecting Pinot Noir wine flavour

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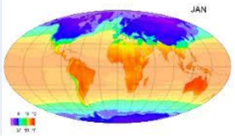
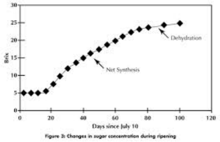
- Soil *(J. of Food, Agric. & Environ. 2012, Vol 10(2), 280-288)*

- Climate *(J. of Wine Research, 2012, Vol 23(3), 203-228)*

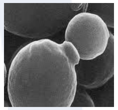


- Grape maturity *(J. of Agric. Food Chem, 2006,54, 8567-8573.)*



- Dehydrated grapes *(Food Chemistry, 2008, 109, 755-762)*

- Yeast *(Aust J. of Grape & Wine Research, 2012, 18, 131-137)*



- Fermentation temperatures *(Food Research Int. 2001, 34, 483-449)*

- Oak contact *(Am. J. Enol. Vitic., 1999, 4, 447-455)*

- Ageing & Oxidation *(Am. J. Enol. Vitic., 1992, 43(1), 90-92)*

Compounds found in Pinot Noir

Y. Fang and M. Qian, *Flavour Frag. J.* 2005; 20: 22-29

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2-phenylethanol (FD = 8192) 

2-methylpropanol & 3-methyl-1-butanol (FD ≥ 4096) 

2-methylpropanoic acid, butanoic acid, 2-methylbutanoic acid,3-methylbutanoic acid (FD ≥ 64)
hexanoic and octanoic acid also FD ≥ 16)

trans-3-Hexenol, *cis*-3-hexenol (FD ≥ 16), Hexanol (FD ≤ 16)  

Benzyl alcohol, linalool & geraniol (FD ≥ 64)  

3-Methylthio-1-propanol, 3-ethylthio-1-propanol (FD ≥ 64)

3-Mercaptohexanol & ethyl 3-(methylthio) propanoate (FD ≥ 16)  

4-Mercapto-4-methylpentan-2-one (FD < 16) – black currant aroma 

Ethyl 2-methylproponoate, ethyl butanoate, 3-methylbutyl acetate, ethyl hexanoate & benzaldehyde (FD ≥ 64) 

Guaiacol, α-terpineol, 4-ethylguaiacol, p-cresol and eugenol (FD ≥ 16)  

m-Cresol, isoeugenol & vinylphenol (FD ≥ 16)

Ethyl 3-methylbutanoate, 3-methylbutyl 2-methylpropanoate , ethyl decanoate , phenylethyl formate & phenylethyl acetate (FD ≥ 16  

Ethyl anthranilate & ethyl 2,3-dihydrocinnamate (FD > 16)  

Whiskey lactone (FD < 16)  & γ-nonalactone (FD ≥ 16) 

3-Methylthio-1-propanal (FD ≥ 16) 

β-damascenone 

1,8 – Cineole (eucalyptol)

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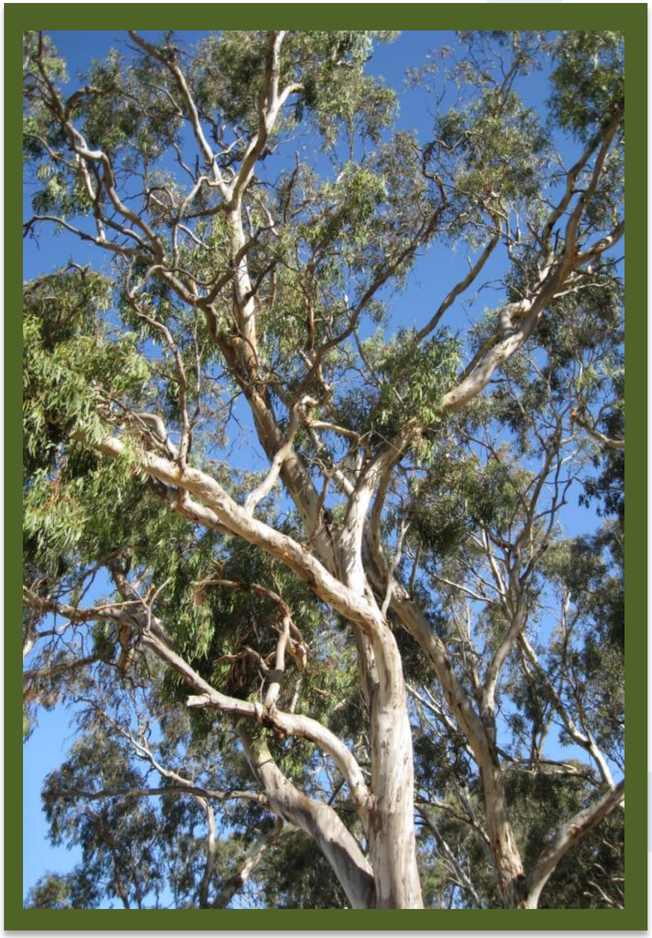
The characteristic aroma is ‘eucalyptus’, ‘fresh’, ‘cool’, ‘minty’, ‘medicinal’ and ‘camphorous’



Aroma detection threshold in a Californian Merlot is 1.1 µg/L

(ETS Laboratory)

Study by the AWRI sensory team found consumers preferred a wine spiked (4 & 30 µg/L) over the unspiked wine. With a cluster (38%) strongly preferring the wine spiked at 30 µg/L.

(AWRI Tech Rev. #189)

Background on 1,8-cineole

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The origin of 1,8-cineole in wine is unclear

- Herve et al reported that the ‘eucalypt’ character in wines occurs when vineyards are surrounded by *Eucalyptus* trees

- Farina et al proposed that terpene compounds such as α-terpineol and limonene are possible precursors of 1,8-cineole

We wanted to identify the source of 1,8-cineole in wine and study factors which affect its concentration

❖Herve, E., Price, S. and Burns, G. Proceedings VII^{ème} Symposium International d’Œnologie, Activities Œnologiques 2003, Bordeaux, France, 19-21 June 2003.

❖Farina et al. *J. Agric. Food Chem.* 2005, 53, 1633-1636.

How wide spread is 1,8-cineole in commercial Australian red wines?

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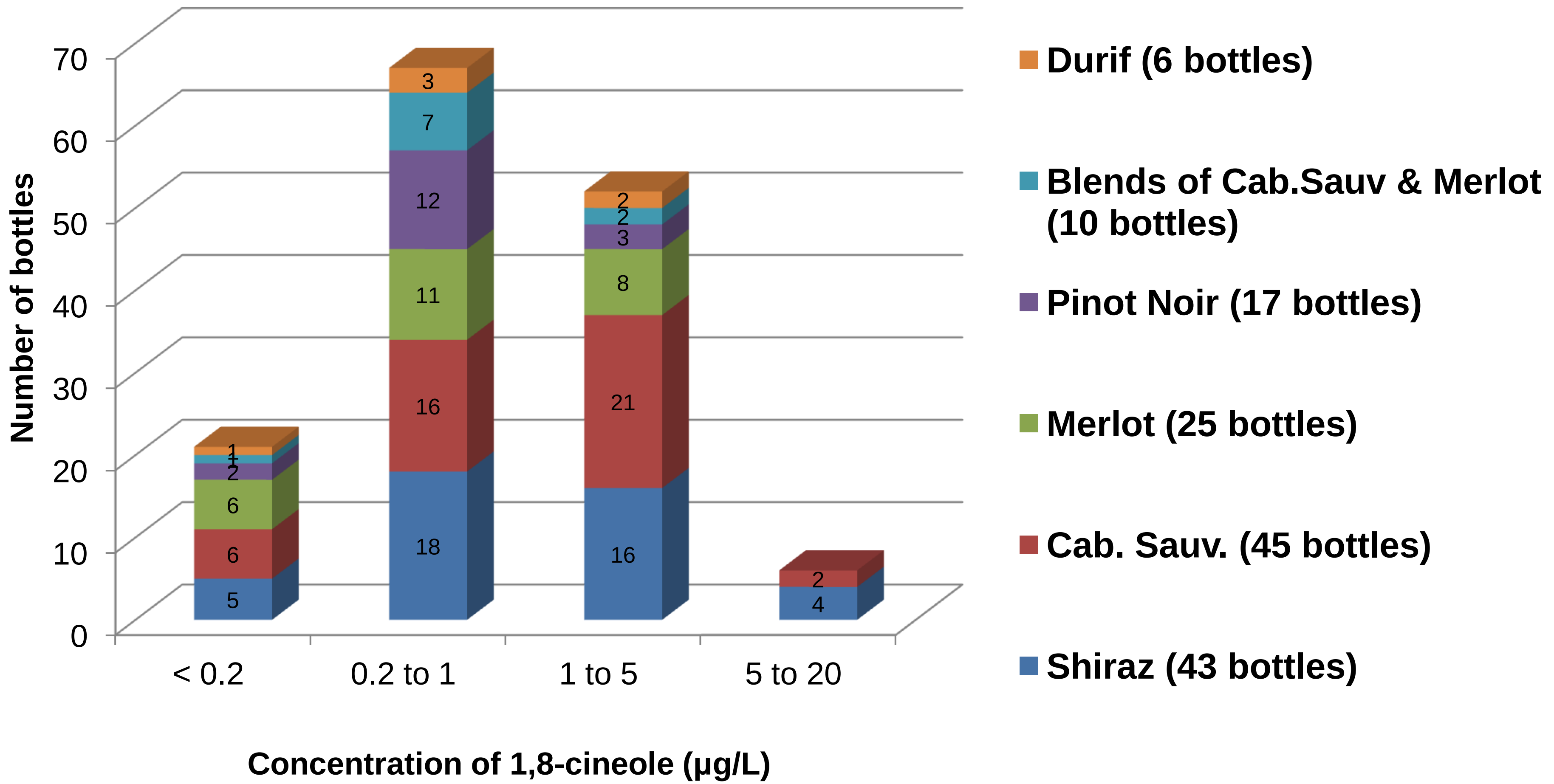

40% contained 1,8-cineole above reported detection threshold.

The highest level of 1,8-cineole found was 19.6 µg/L

We have previously found that:

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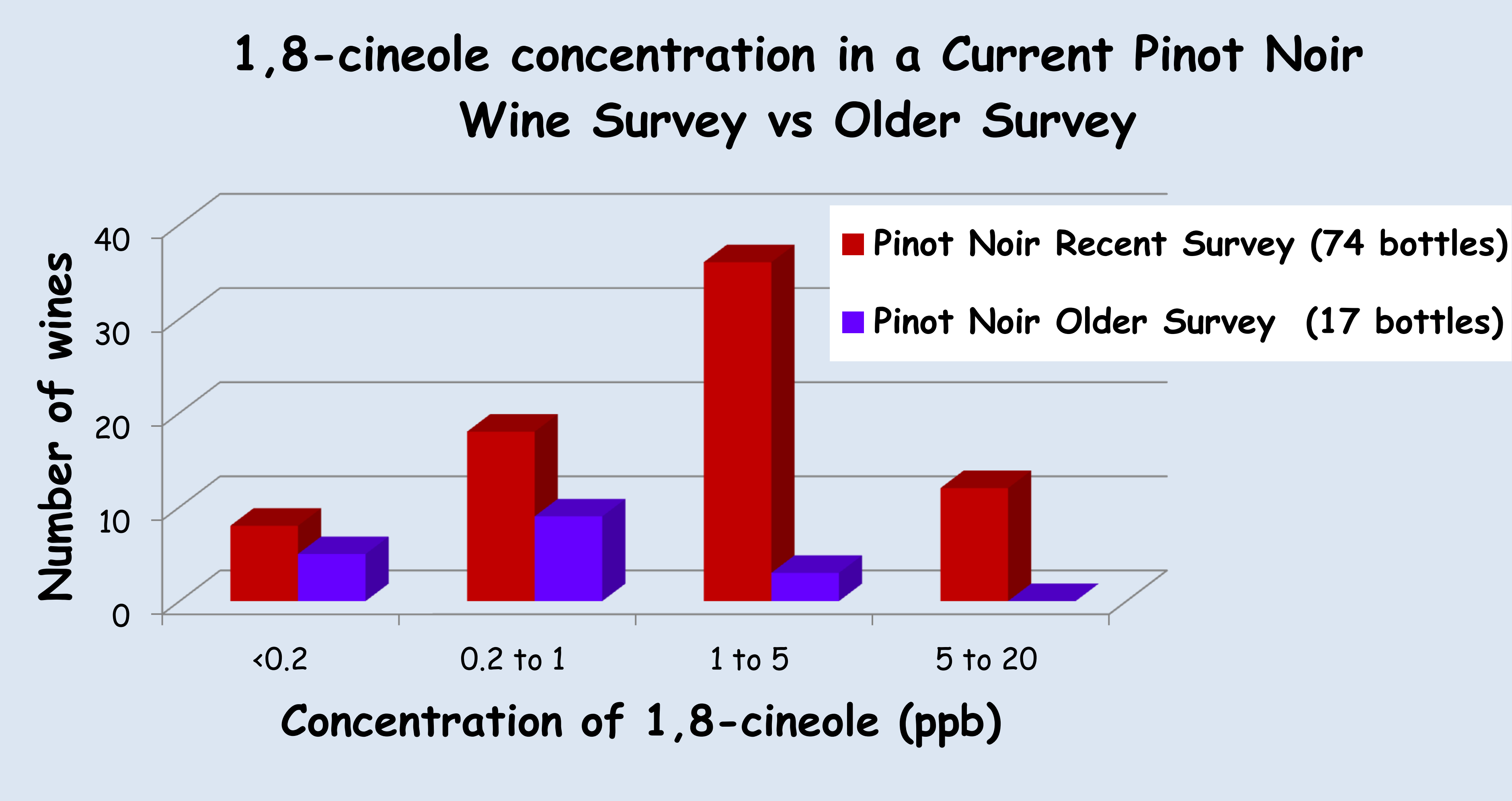

65% of the current Pinot Noir wines analysed contained 1,8-Cineole at or above its aroma detection threshold

1,8-cineole concentration in Pinot Noir Wines from Victoria & Tasmania

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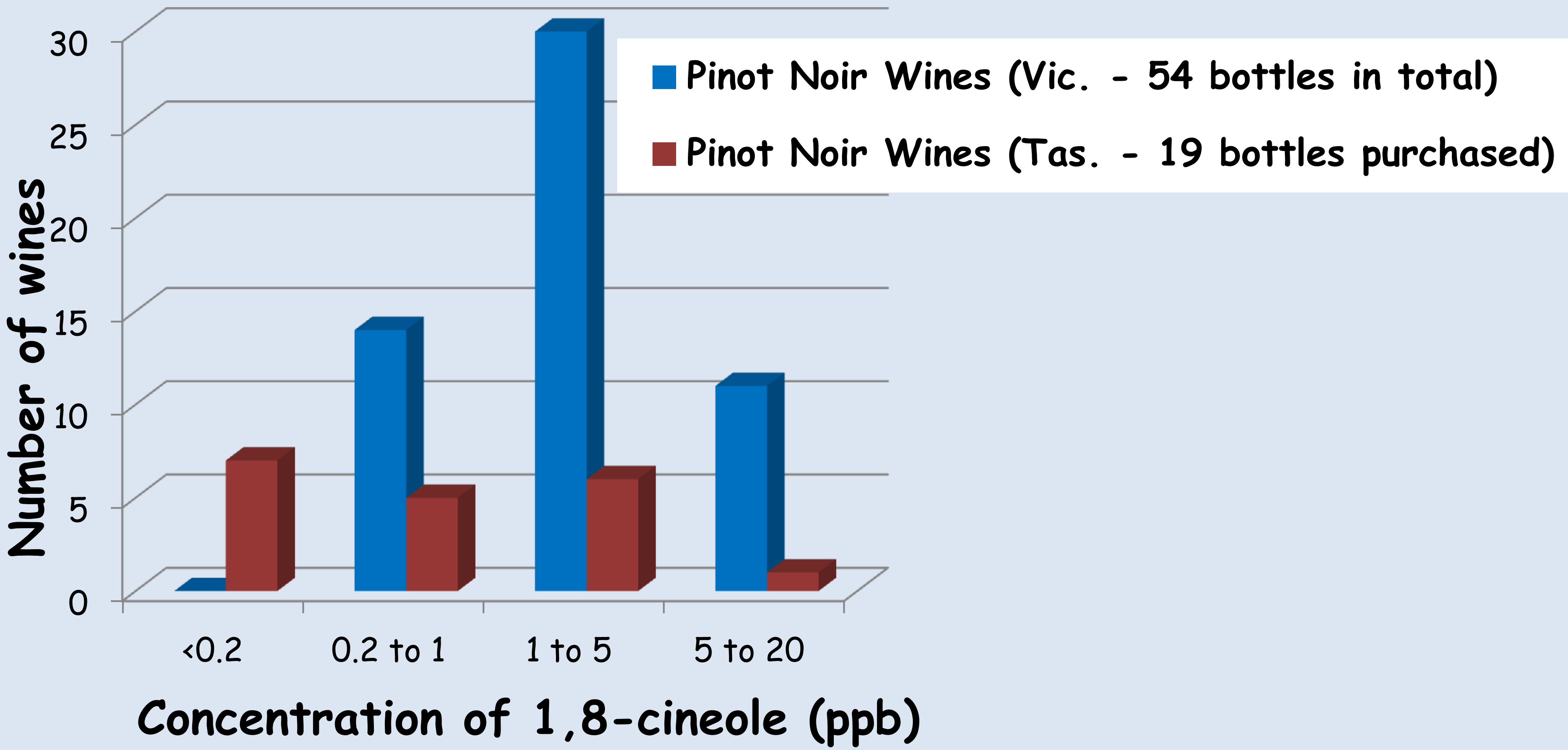

75% of the Victorian & 37% of the Tasmanian Pinot Noir wines analysed contained 1,8-Cineole at or above its aroma detection threshold

1,8-cineole concentration in a New Pinot Noir wine survey

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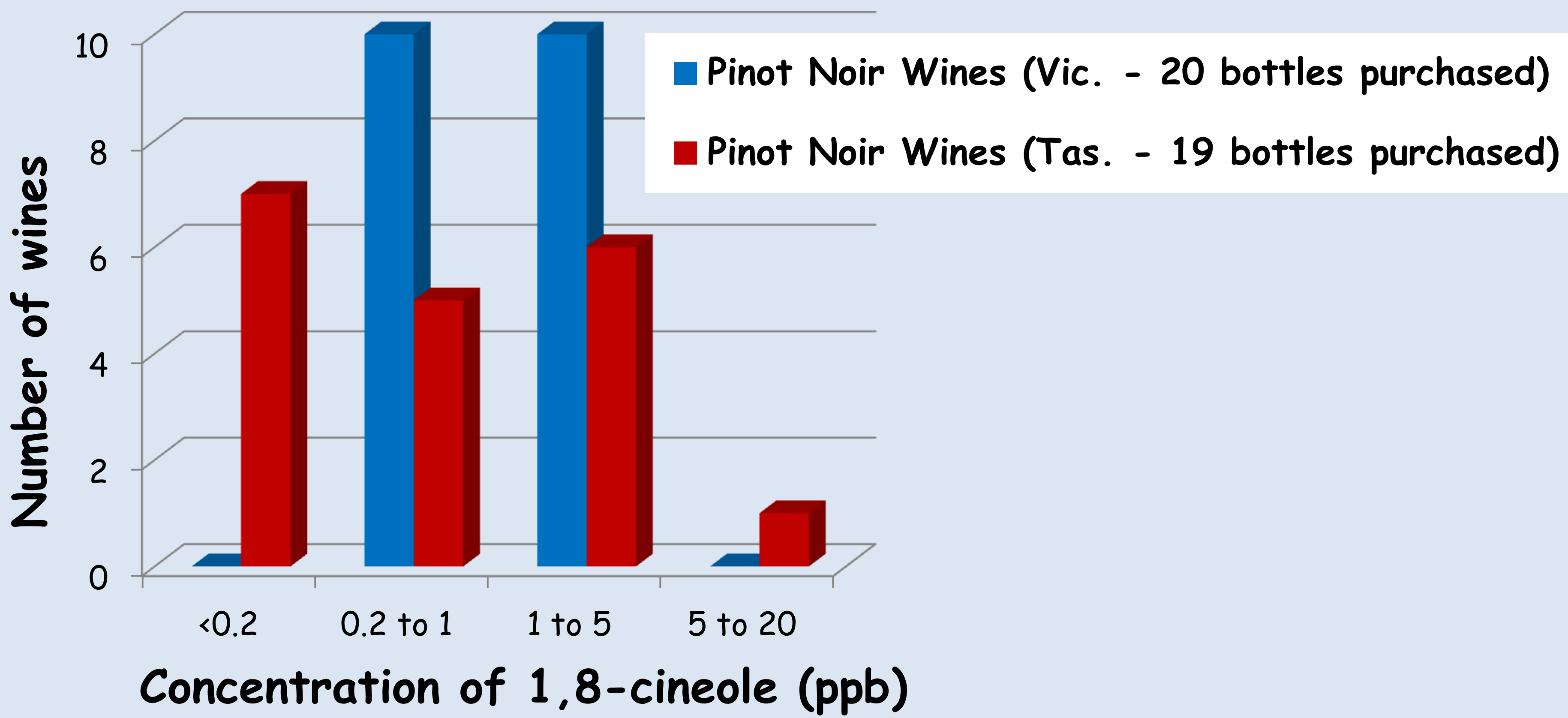

50% of the purchased Victorian & 37% of the Tasmanian Pinot Noir wines analysed contained 1,8-Cineole at or above its aroma detection threshold

Is 1,8-cineole found in significant concentrations in Australian white wine?

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NO!

Out of 44 white wines
(12 Rieslings, 10 Sauvignon Blancs, 10 Semillons and 12 Chardonnays)
1,8-cineole was not detected above 0.8 µg/L in any wine

Formation of 1,8-cineole from precursors?

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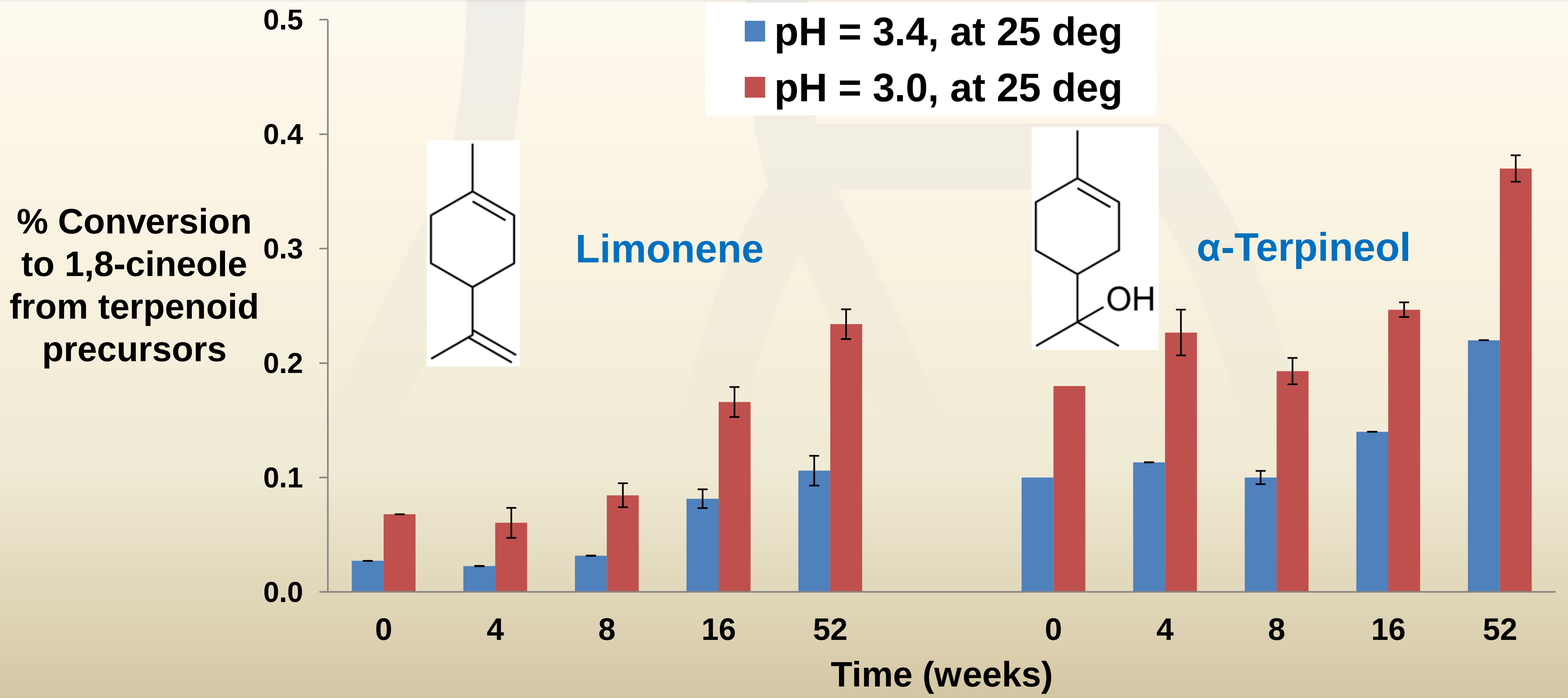

Limonene and α-terpineol were not significant precursors

After 12 months <0.4% conversion to 1,8-cineole

(i.e. sub-threshold formation) at both pH levels

Wines obtained from a single vineyard in Western Australia & the Yarra Valley

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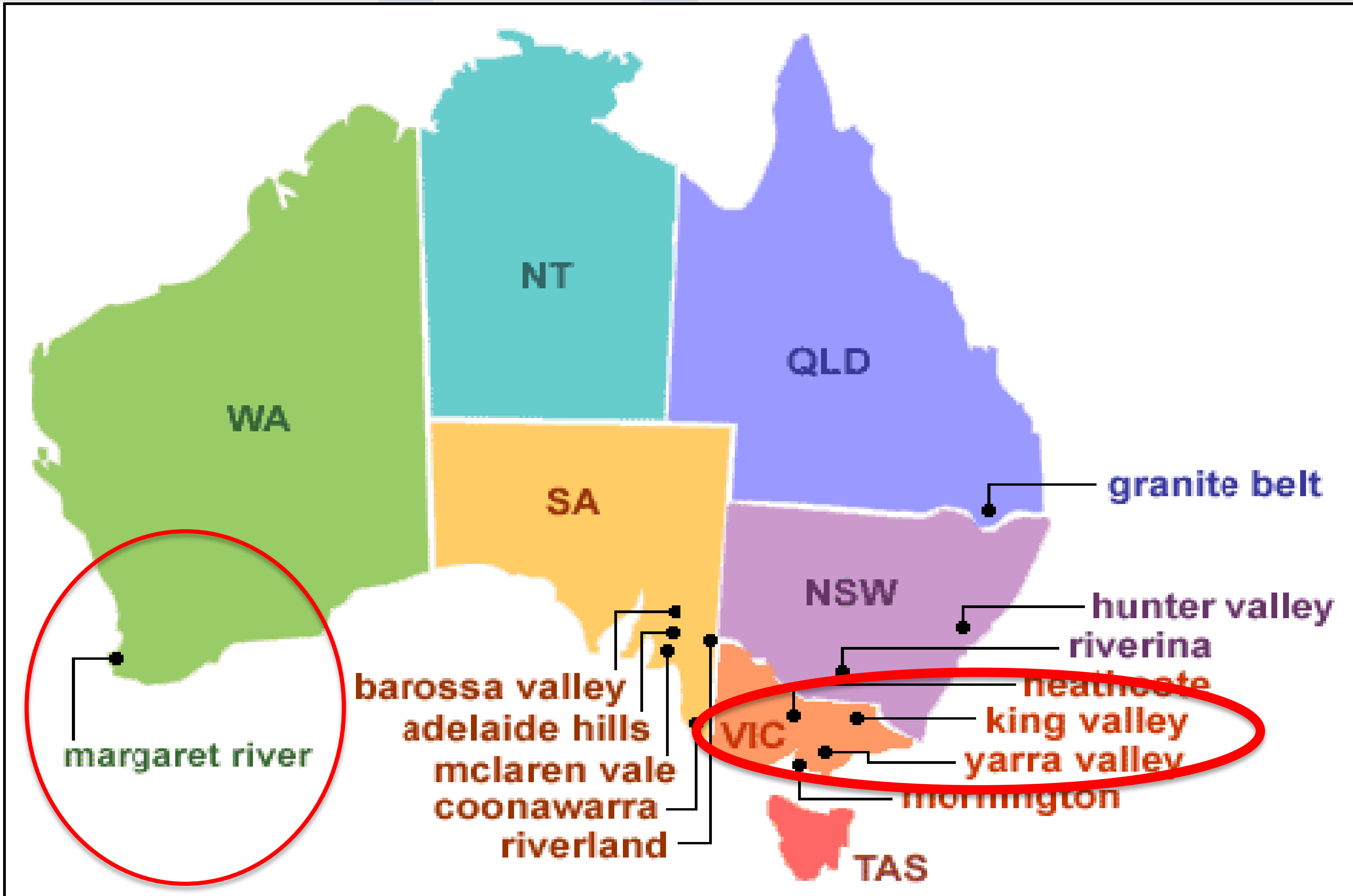
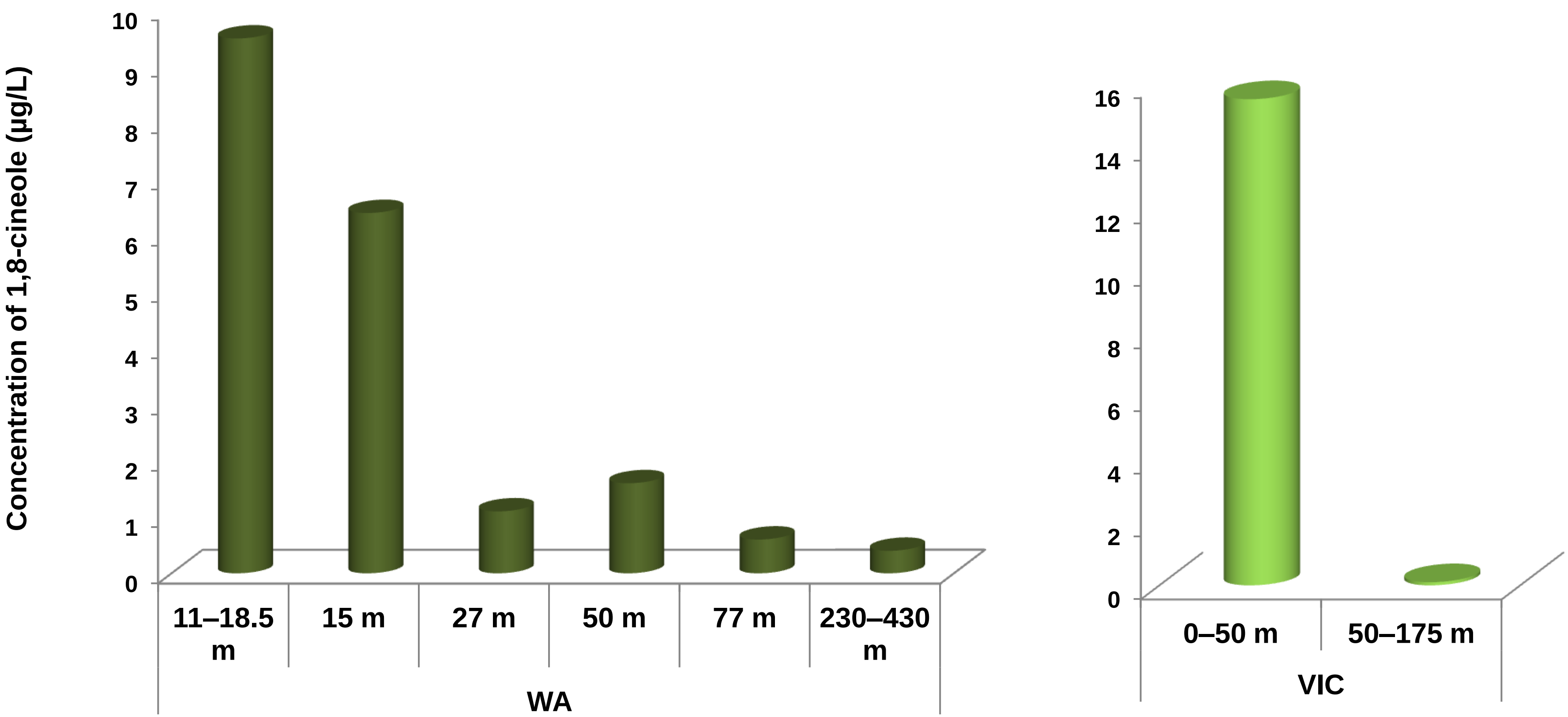


1,8-Cineole concentration decreases

further away from Eucalyptus trees



Commercial ferments

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- Low concentration found in all white wines – is compound accumulated in the skins and extracted during fermentation whilst on skins?
  - Therefore two commercial ferments were monitored each day throughout fermentation for 1,8-cineole concentration

Cineole increases during fermentation – with skin contact

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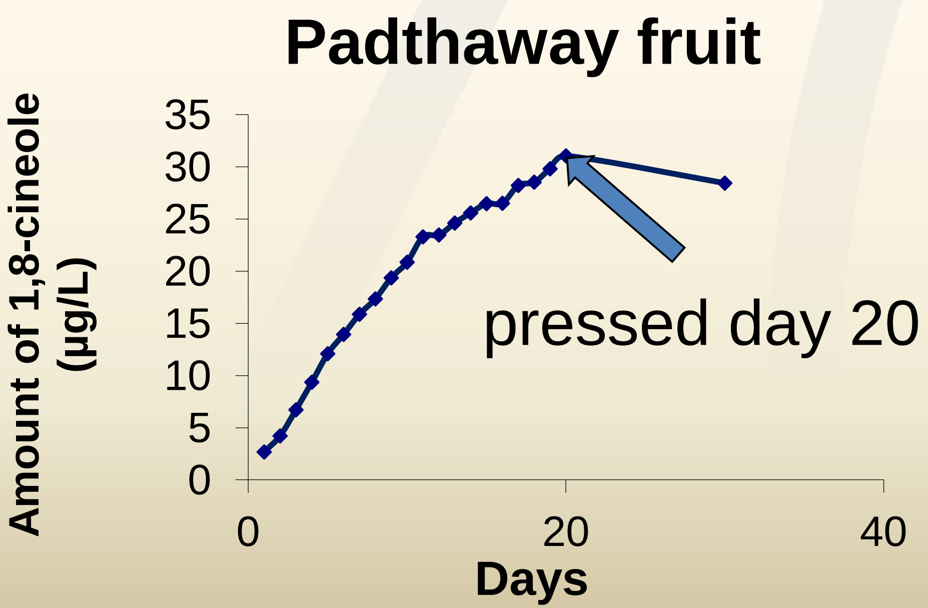
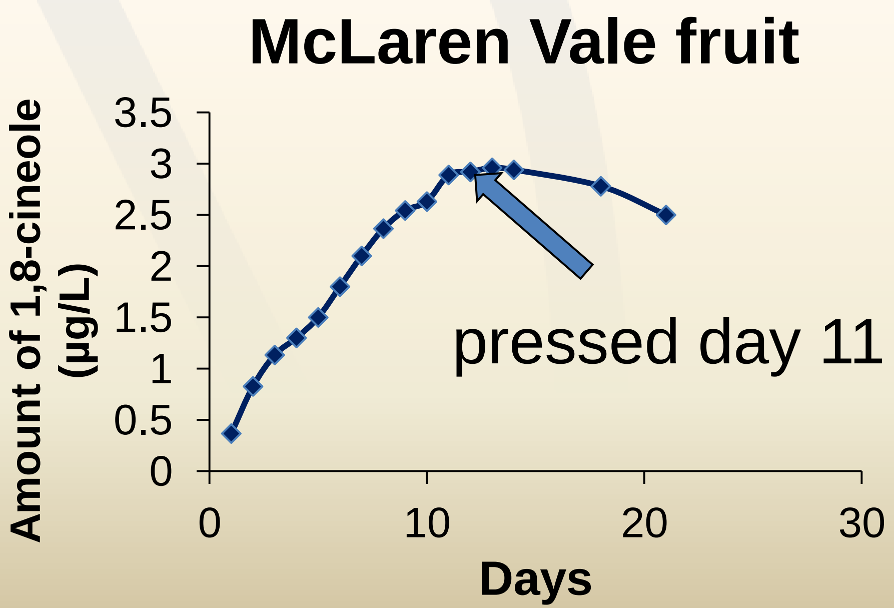
Changes of 1,8-cineole during fermentation

Two commercial shiraz fermentations - Samples were collected and analysed daily

Ferment (1) 20 tonne closed fermentor with Padthaway fruit and

(2) 10 tonne open fermentor with McLaren Vale fruit





Continuous increase in 1,8-cineole concentration, which ceased at pressing off of the skins. This indicated to us that the compound was extracted from the skins and/or MOG

Vineyard studies

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A more detailed study of the relationship between grape composition and proximity to *Eucalyptus* trees was conducted over three vintages.

Grape bunches

Grape stems

Grape Leaves

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Eucalyptus **trees**

Vineyard Study

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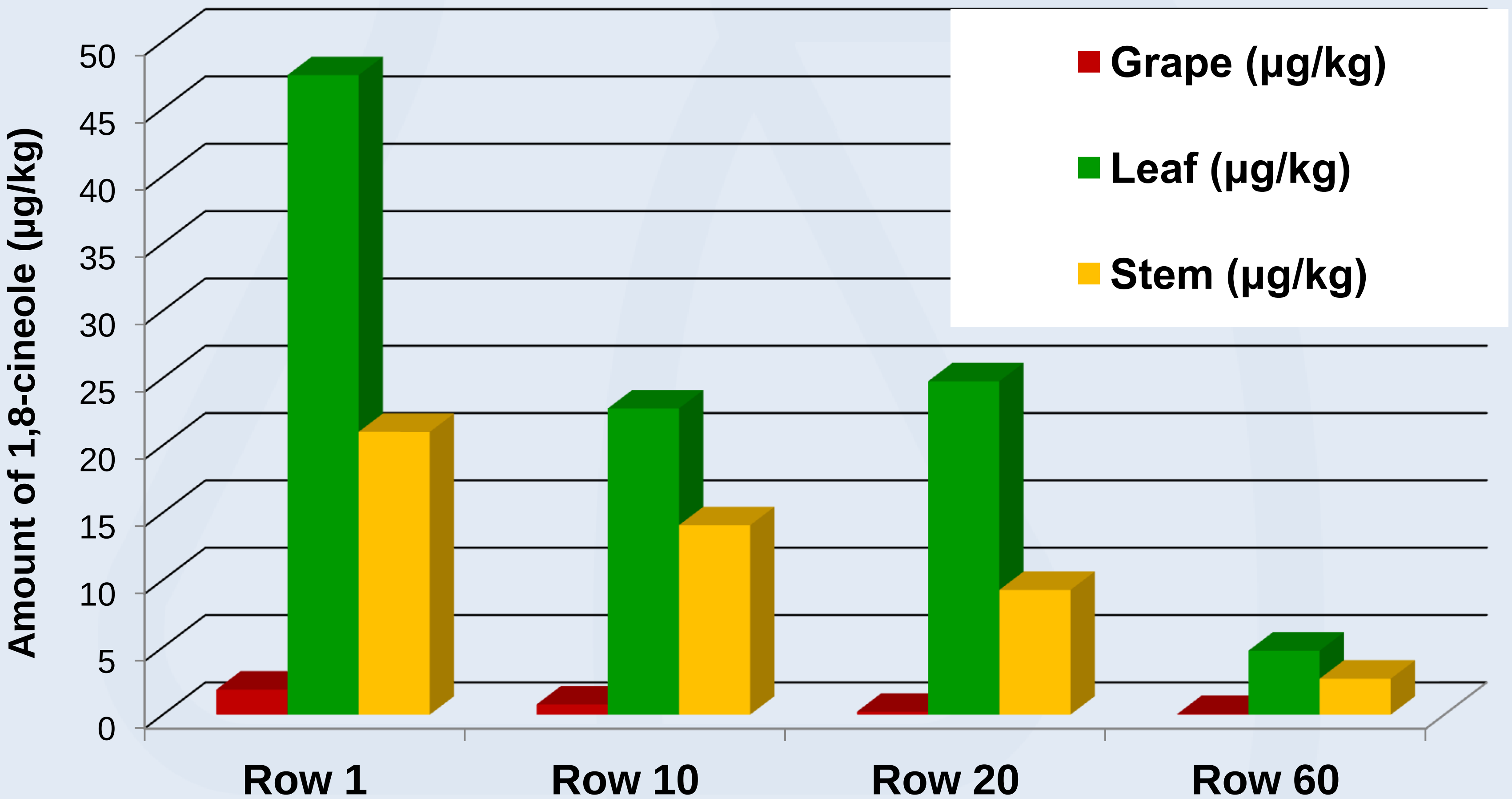
Concentration of 1,8-cineole measured in grapes, grape leaf and stems



Concentration of 1,8-cineole in grape skins & grape pulp

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0.36 ng/berry in the grape pulp

1.31 ng/berry in the grape skins

Effect of MOG

In Row 1

Found a bunch of *Eucalyptus* leaves and bark in canopy

Total MOG 67.5 gm

in 1 tonne fermenter , with 100% extraction

= 213 µg/L of 1,8-cineole

To determine the effect of MOG on 1,8-cineole concentration

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Block with a history of high 1,8-cineole was chosen

Only the first 3 Rows picked

Rows 1 to 3

- 550 kg of Shiraz Fruit
- Hand picked & randomised
- Duplicate 50 kg lots
- Then Crushed

Fermentation design

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Treatment 1

Rosé Pressed Immediately

Treatment 3

Grape Leaves & Stem

Treatment 2

Control Hand Plucked

Treatment 4

***Eucalyptus* Mix**

Fermentation curves: Influence of MOG

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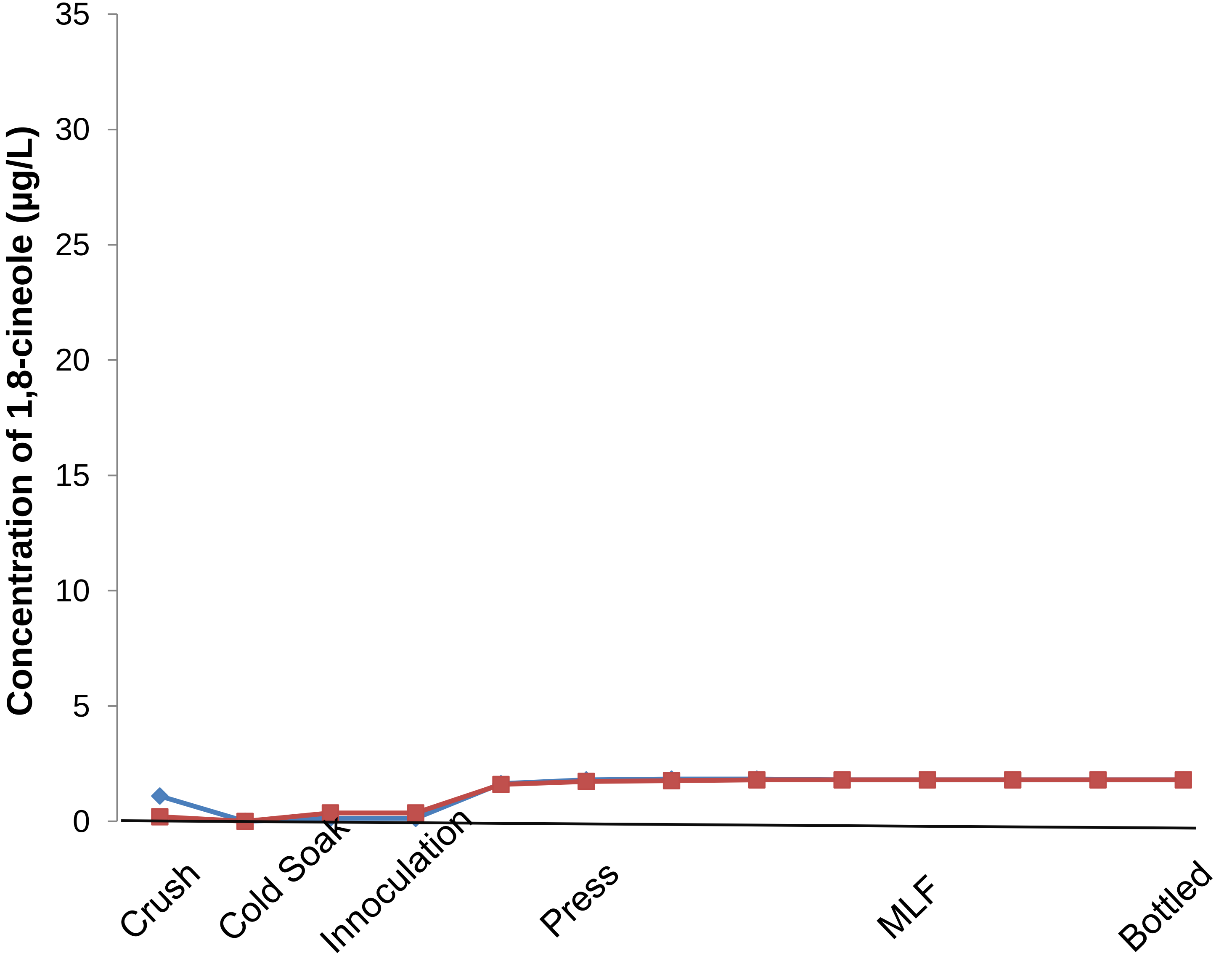

Control
Hand plucked
Rep 1 & 2

Fermentation curves: Influence of MOG

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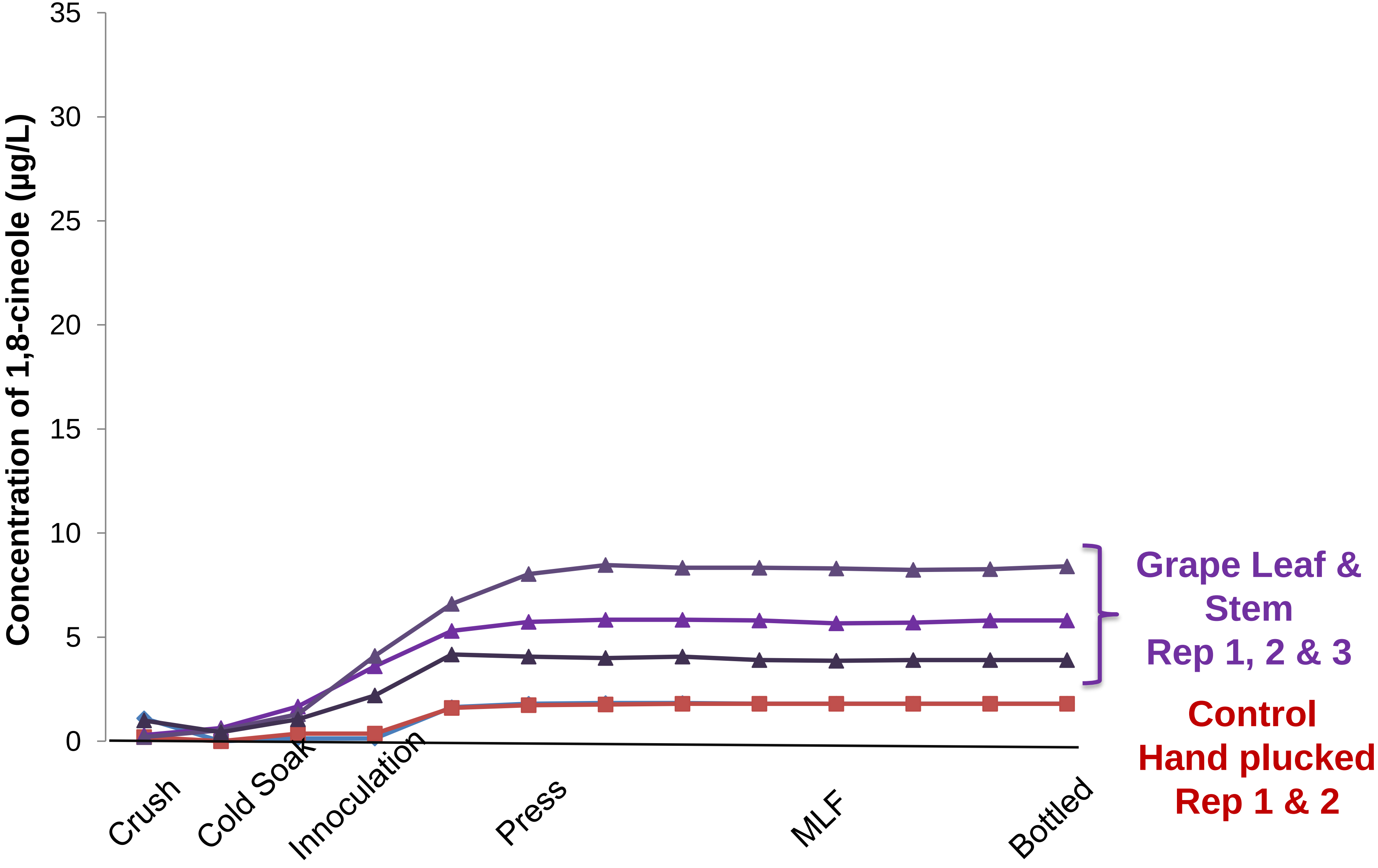

Fermentation curves: Influence of MOG

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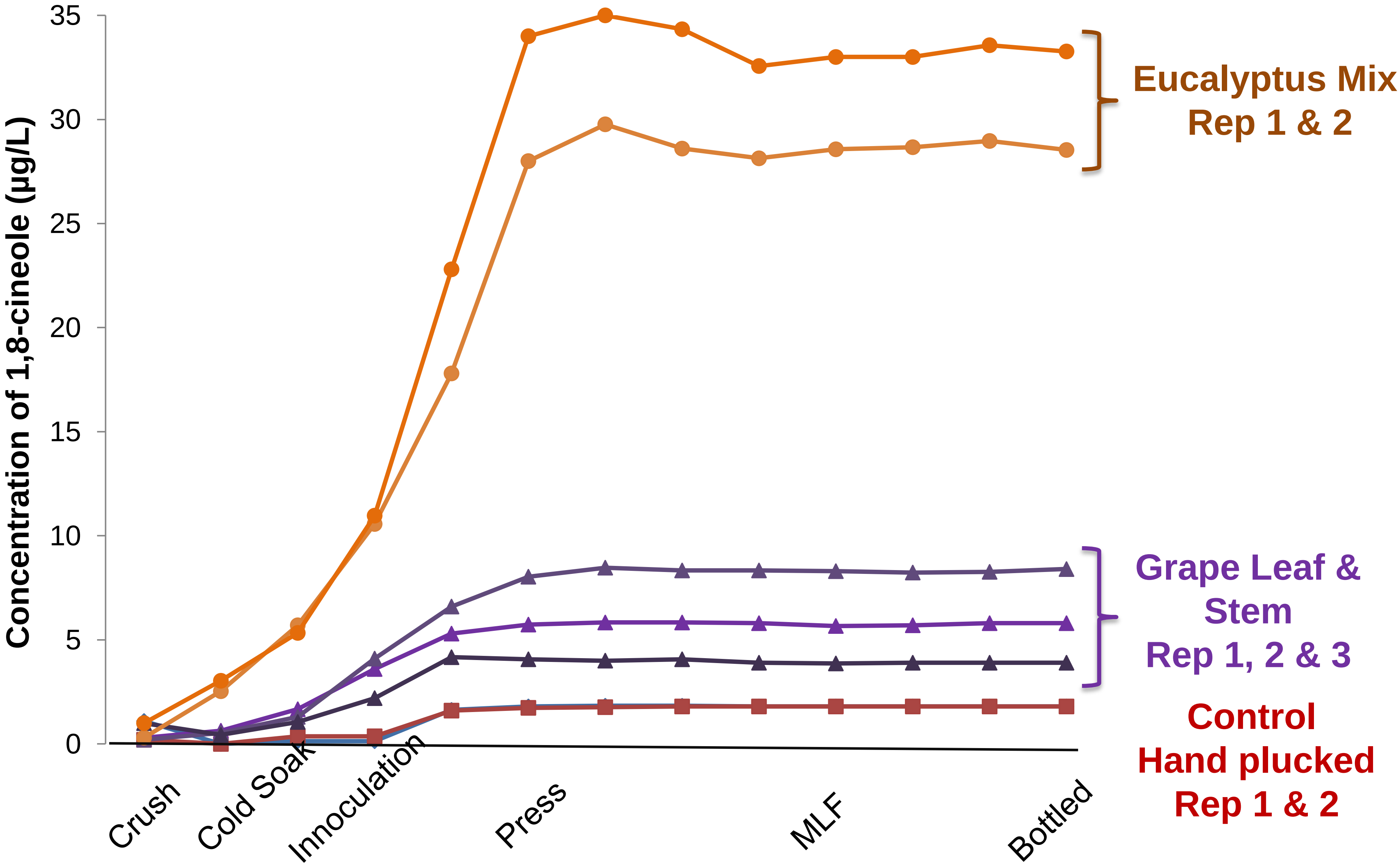

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33 *Eucalyptus* leaves found –

In 550 kg of hand picked fruit

Yet fruit is often harvested mechanically

Additional Experiments

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- Translocation is not occurring from the roots of the vine or the grape leaves to the grapes.
- 1,8-Cineole is extremely stable in wine
- Minimal scalping observed for natural cork or screw cap closures and a 14% reduction of 1,8-cineole under synthetic closure over a 12 month period

Concentration of rotundone in ferment treatments

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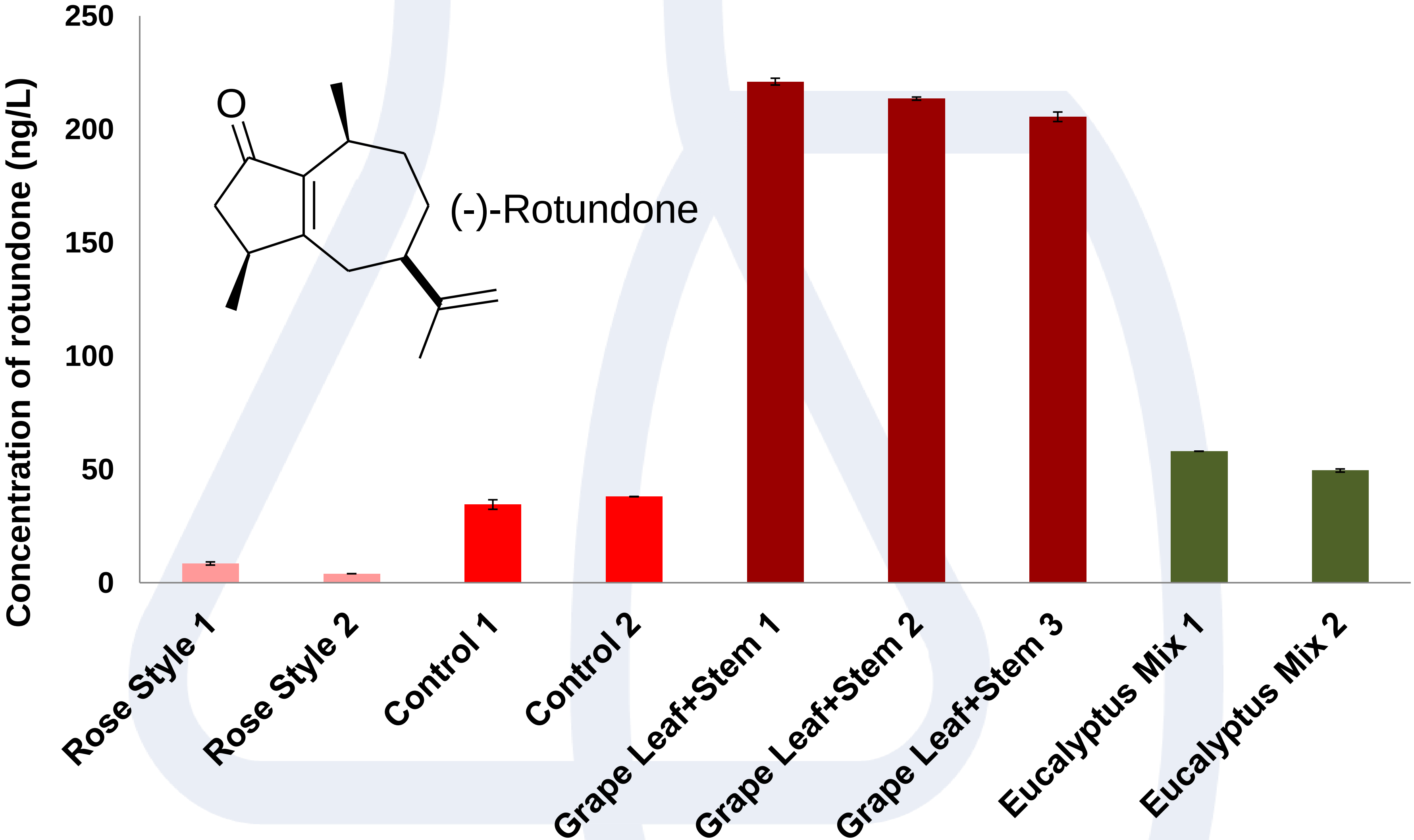

Concentration of rotundone in Grape Leaf and Grape Stem

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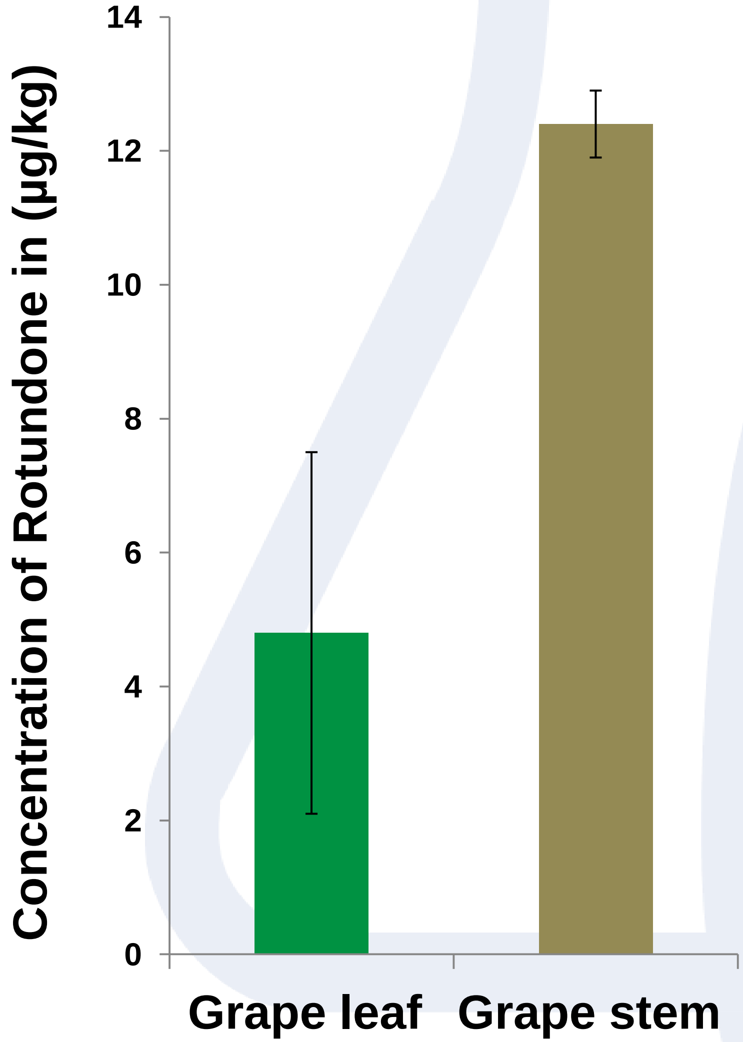
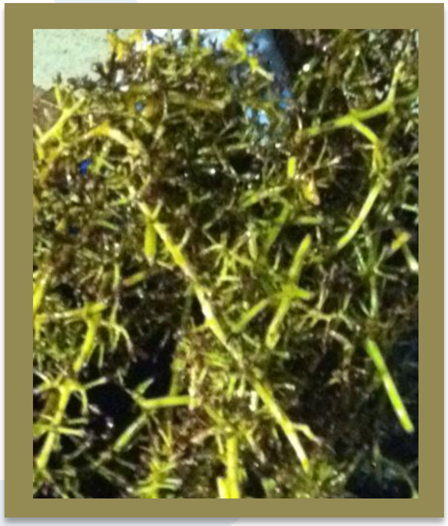


Leaf (100% Extraction) in 50 kg Ferment ≈ 85 ng/L



Stem with (100% Extraction) in 50 kg Ferment ≈ 500 ng/L

Leaf + Stem with 100% Extraction in 50 kg Ferment ≈ 585 ng/L

The presence of Grape Leaves & Stems

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- Not only impact 1,8-cineole levels: can also impact wine rotundone concentrations
- These can lead to altered wine sensory characteristics
- More to consider than grape berry composition alone when investigating wine aroma

Conclusions

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- Limonene and α-terpineol do not contribute significantly to the 1,8-cineole concentration in young wines
- The greatest amount of 1,8-cineole in grapes, grape leaf and stem is found in the samples closest to the *Eucalyptus* trees
- The amount of 1,8-cineole increases during fermentation with skin contact
- The presence of *Eucalyptus* leaves, and to a lesser extent grape vine leaves and stems can be a major contributor to 1,8-cineole concentration in wine

Tips to modulate 1,8-cineole in wine

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- Keep fruit harvested close to trees separate from the rest and blend if desired

To decrease concentrations of 1,8-cineole if desired you could-

- Remove *Eucalyptus* leaves & twigs from canopy close to trees before machine-harvesting
- Eliminate other MOG (especially from rows close to trees) from ferments i.e. sorting fruit on a conveyer belt

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Evolution and Occurrence of 1,8-Cineole (Eucalyptol) in Australian Wine

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Vineyard and Fermentation Studies To Elucidate the Origin of 1,8-Cineole in Australian Red Wine

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Thank you – come visit us in Adelaide

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1,8-Cineole (eucalyptol)

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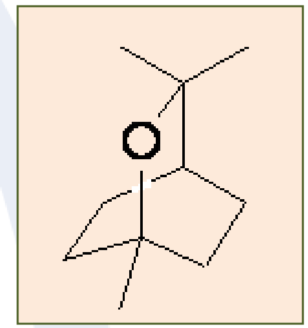
- The characteristic aroma is ‘eucalyptus’, ‘fresh’, ‘cool’, ‘minty’, ‘medicinal’ and ‘camphorous



- Aroma detection threshold in a Californian Merlot is 1.1 µg/L (ETS Laboratory)

- Found only in red wines

- Lower concentration: 5 µg/L

- Higher concentration: 40 µg/L

2-Phenylethanol (phenylethyl alcohol)

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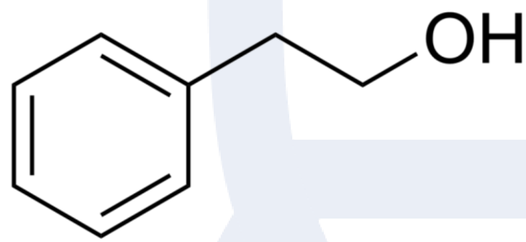

- The characteristic aroma is ‘rose’, ‘honey’, ‘lilac’ and ‘spice’

- Aroma detection threshold in a 1 mg/L in water
- Found in Pinot Noir wine between 24 to 37 mg/L
- Concentration spiked: 14.4 mg/L