Smoke Taint –
The latest research from the AWRI

AWRI Australian Wine Research Institute

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The latest AWRI research

Jiang, W., Parker, M., Hayasaka, Y., Simos, C. and Herderich, M. **2021**. Compositional Changes in Grapes and Leaves as a Consequence of Smoke Exposure of Vineyards from Multiple Bushfires across a Ripening Season. *Molecules*, 26 (11): 14.

Coulter, A., Baldock, G. A., Parker, M., Hayasaka, Y., Francis, I. L. and Herderich, M. **2022**. The concentration of smoke marker compounds in non-smoke-exposed grapes and wine in Australia. *Aust. J. Grape Wine Res.*, 28 (3): 459-474.

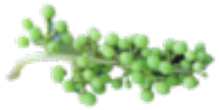
Jiang, W., Bilogrevic, E., Parker, M., Francis, I. L., Leske, P., Hayasaka, Y., Barter, S. and Herderich, M. J. **2022**. The effect of pre-veraison smoke exposure of grapes on phenolic compounds and smoky flavour in wine. *Aust. J. Grape Wine Res.*

Bilogrevic, E., Jiang, W., Culbert, J., Francis, L., Herderich, M. and Parker, M. **2023**. Consumer response to wine made from smoke-affected grapes. *Oeno One*, 57 (2): 417-430.

Parker, M., Jiang, W. M., Bilogrevic, E., Likos, D., Gledhill, J., Coulter, A. D., Cowey, G. D., Simos, C. A., Francis, I. L. and Herderich, M. J. **2023**. Modelling Smoke Flavour in Wine from Chemical Composition of Smoke-Exposed Grapes and Wine. *Aust. J. Grape Wine Res.*, 2023: 1-14.

Key questions

What level of smoke exposure produces ‘smoke taint’ in wines?

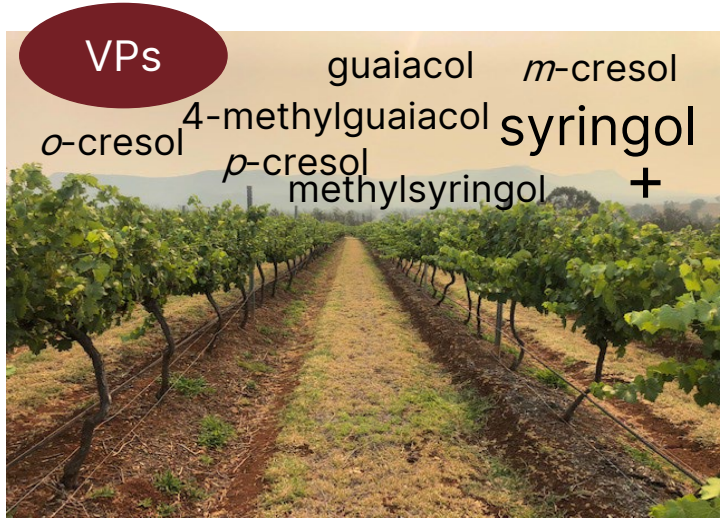


Can pre-veraison smoke exposure produce tainted wines?

Are all varieties the same, or can some varieties tolerate more smoke exposure?

And how do consumers respond to smoke affected wines?

Smoke compounds in grapes and wine



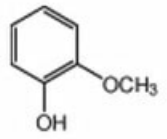
uptake

conversion in grapes

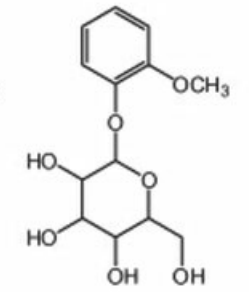
sugar

sugar

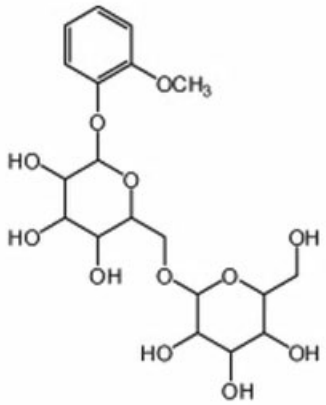
VPs



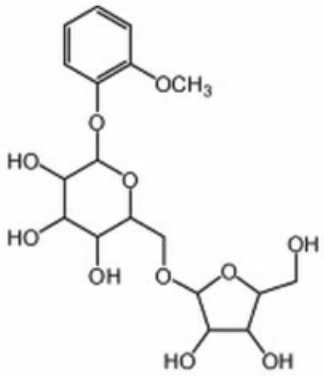
1: guaiacol



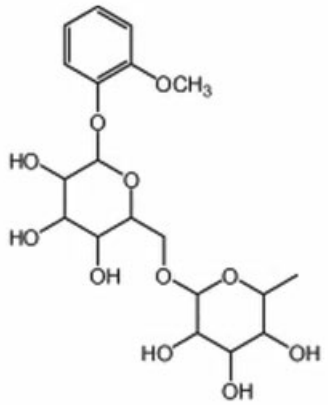
2: guaiacol glucoside (GuG)



3. Guaiacol glucose glucoside



4. Guaiacol pentose glucoside

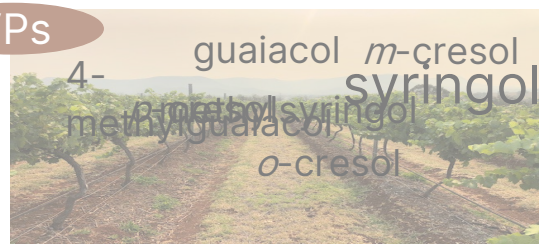


5. Guaiacol rutinoside

Volatile phenols

Non-volatile glycosides

Smoke compounds in grapes and wine



uptake

conversion in grapes

sugar

sugar

VPs

Glycosides

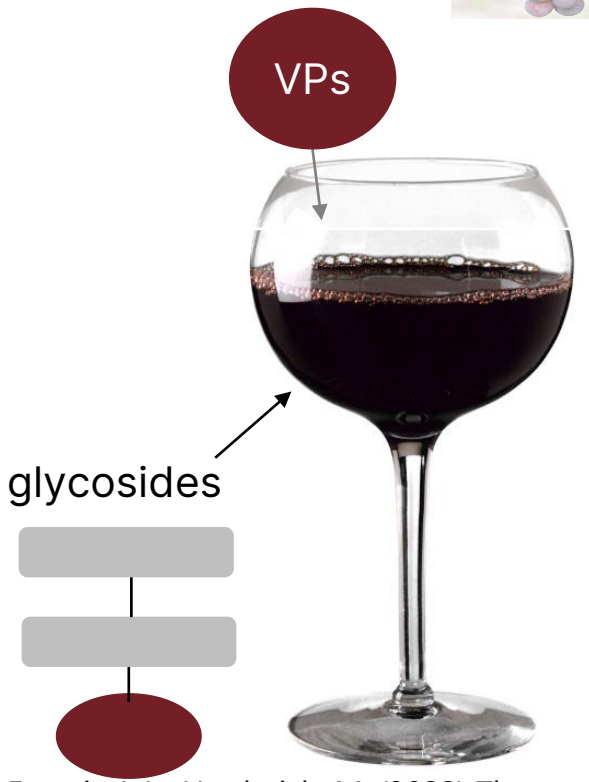
Biomarker SyGG
syringol gentiobioside

Smoky aroma

guaiacol + cresols

Smoky aftertaste

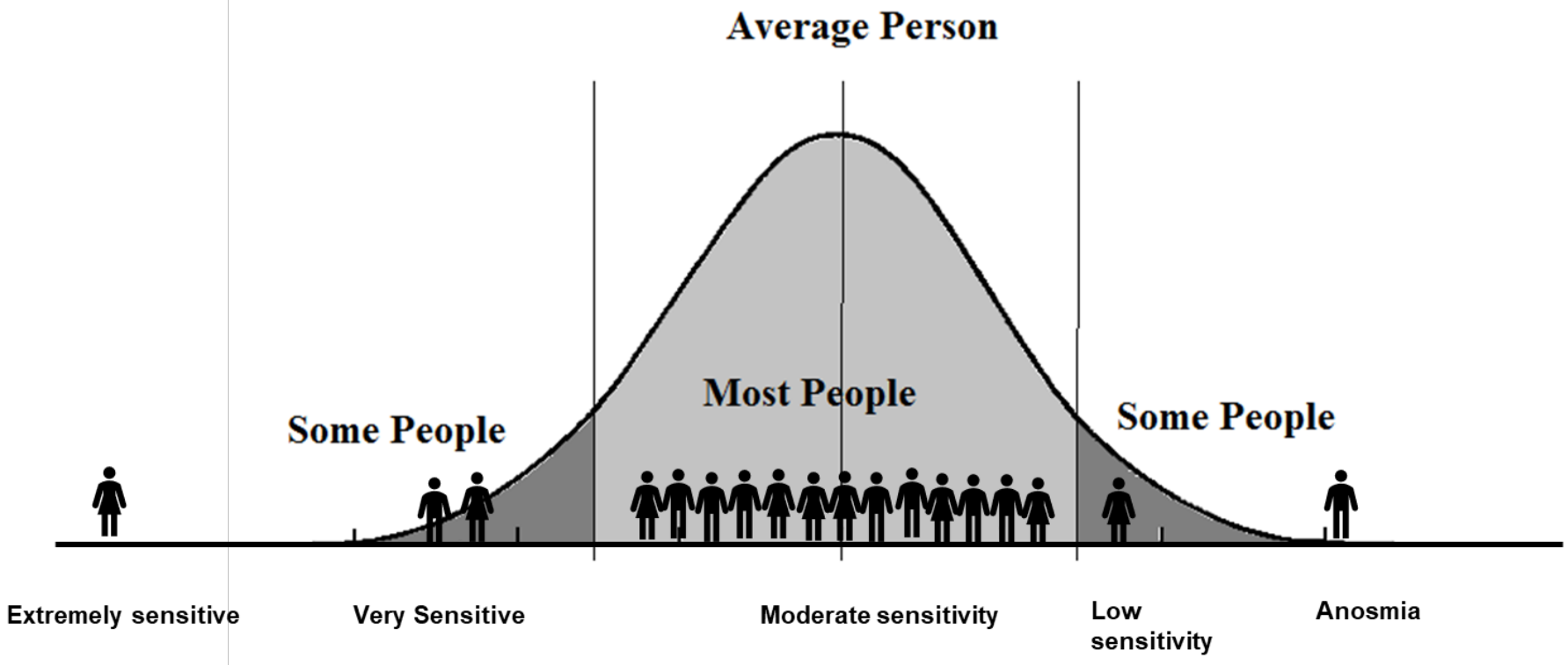
release of VPs from glycosides in-mouth

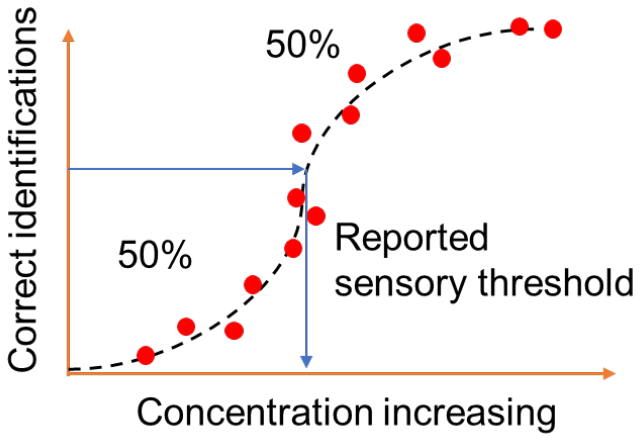


release of VPs from glycosides during winemaking

Coulter, A.; Baldock, G. A.; Parker, M.; Hayasaka, Y.; Francis, I. L.; Herderich, M. (2022) The concentration of smoke marker compounds in non-smoke-exposed grapes and wine in Australia. Australian Journal of Grape and Wine Research 28: 459-474.

Variation in sensitivity





The consumer response to smoke exposed wines

Recruitment Criteria

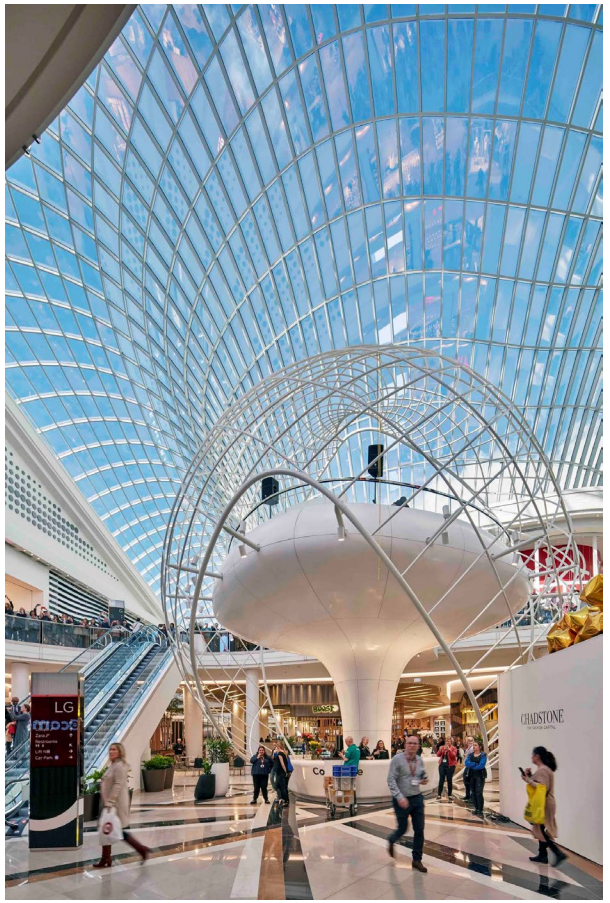
- Regular **red/white/rosé** wine drinkers
- 50% females, 50% males (except for the Rosé study)
- Ranging from 18-65 years old
- Make at least 50% of the wine purchase decisions
- Spend more than $10 on red wine purchases

Consumer Testing – Central Location Tests

AWRI facilities, Urrbrae, SA

Or

External facilities, Chadstone Victoria



- Three separate consumer studies: regular Shiraz/Charonnay/Pinot Noir Rosé wine drinkers

Consumer Testing

Please taste the wine in front of you, and mark the one phrase that best describes your **overall opinion** about the wine.

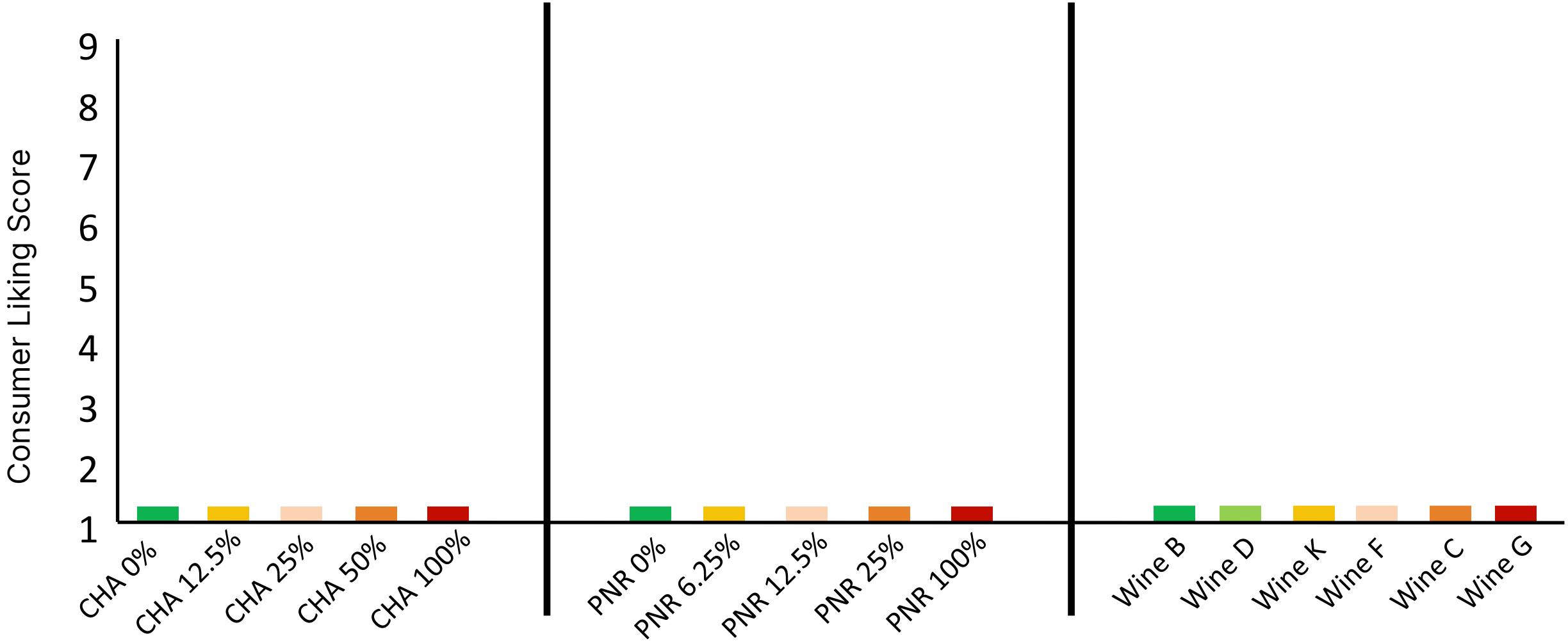
- ☐ Like Extremely
- ☐ Like Very Much
- ☐ Like Moderately
- ☐ Like Slightly
- ☐ Neither Like nor Dislike
- ☐ Dislike Slightly
- ☐ Dislike Moderately
- ☐ Dislike Very Much
- ☐ Dislike Extremely

- Rosé Pinot Noir (dilutions)
- Chardonnay (dilutions)
- Shiraz (various smoke exposed vineyards)

Glasses: randomised order

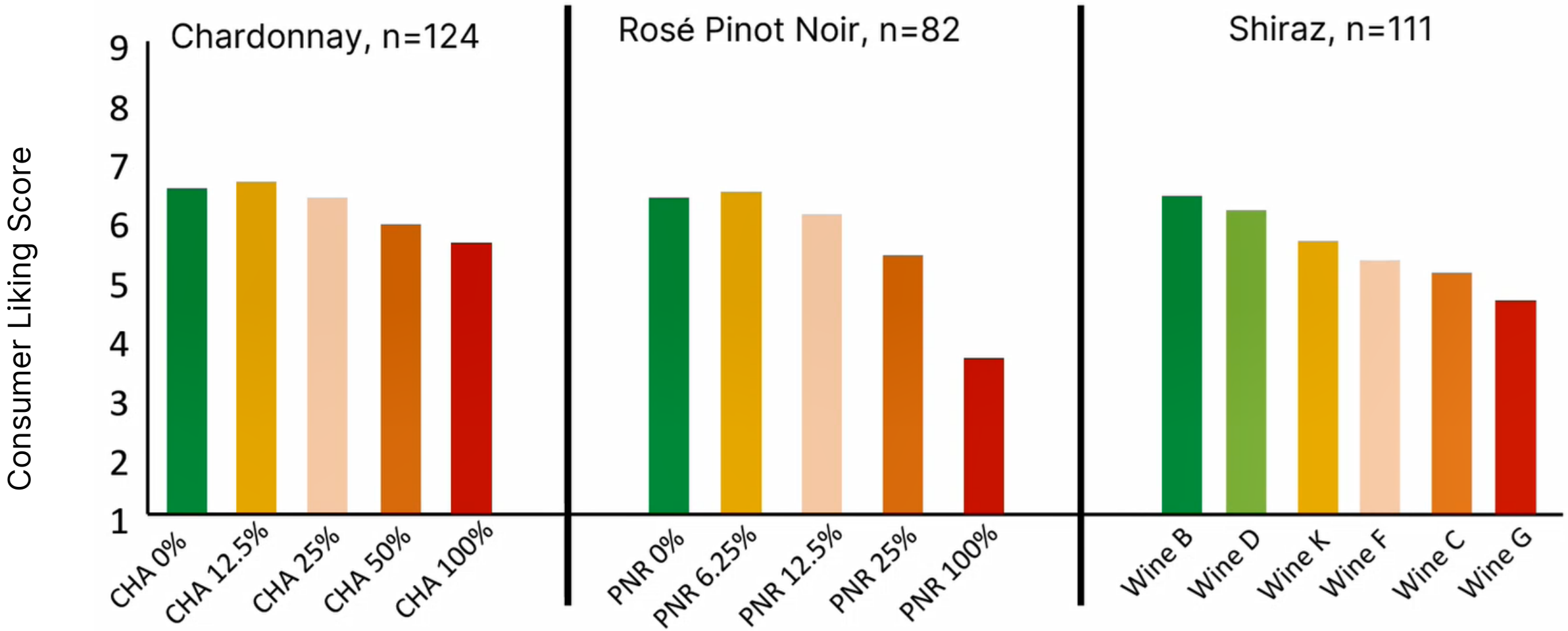
Consumer response to smoke affected wines

Low Smoke F scores → High Smoke F scores

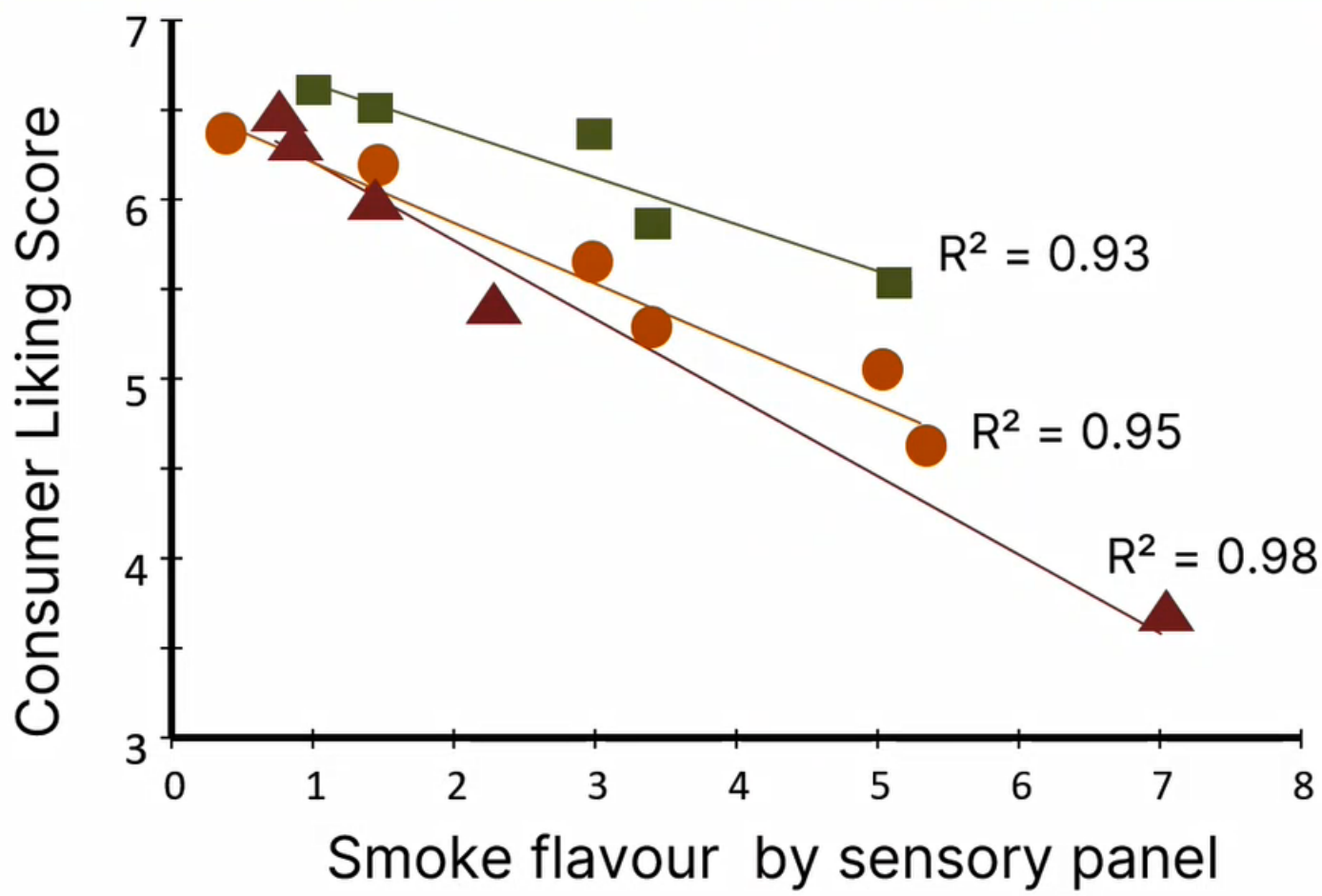


Consumer response to smoke affected wines

Low Smoke F scores → High Smoke F scores



Consumer liking and smoke flavour



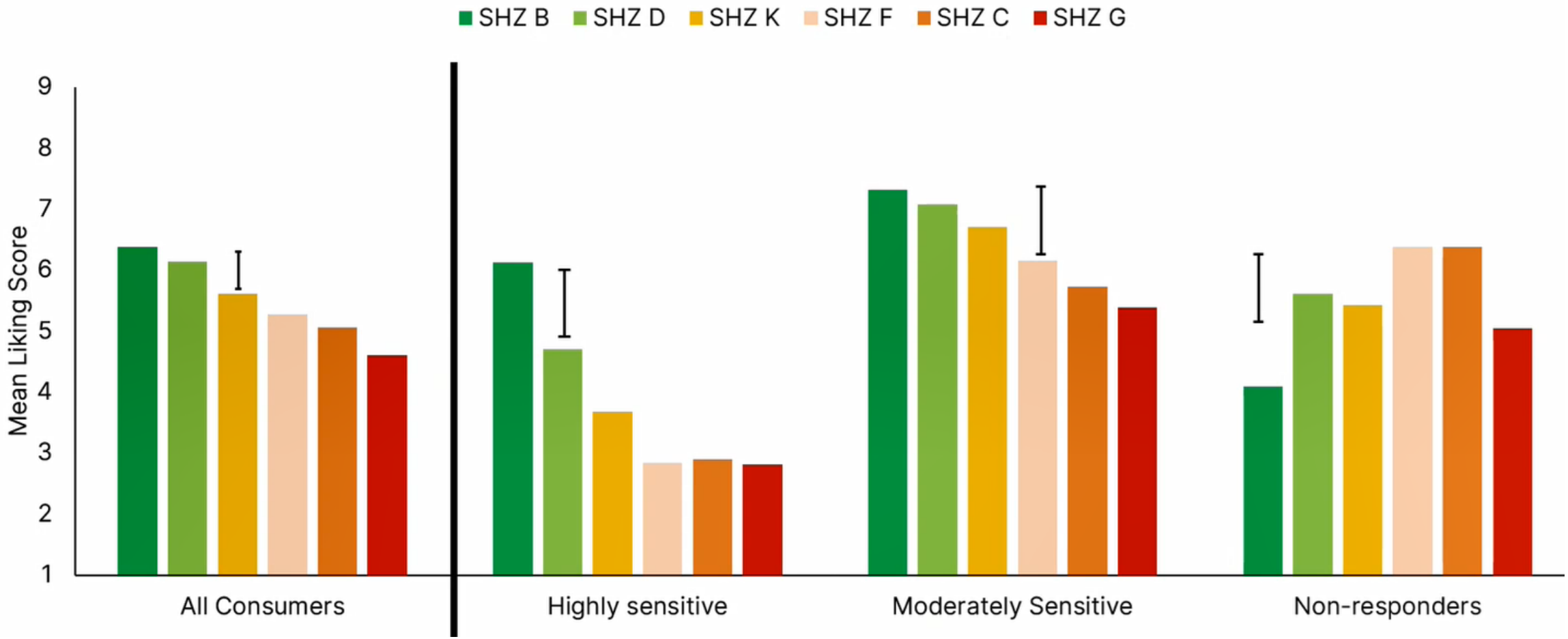
Chardonnay
n=124

Shiraz
n=111

Pinot Noir Rosé
n=82

Consumer response to smoke affected wines

Low Smoke F scores → High Smoke F scores



Summary

Take-home messages

- Consumers generally disliked smoke flavour in all three styles of wine
- Each wine style had a different intensity of smoke character that was disliked by the consumers
- There was a ‘more sensitive’ group of consumers in each wine style (21-53%)
- A highly trained and screened smoke specific panel had very strong correlations for predicting consumer response.

Pre-veraison smoke exposure of vineyards affects wine flavour

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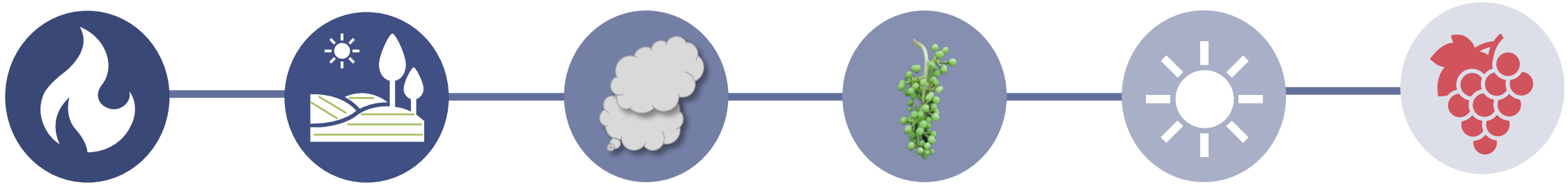
Photo: Peter Leske

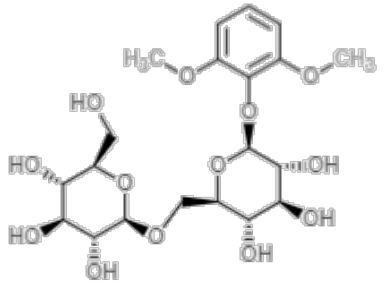
Brief history of 2019 Cudlee Creek fire event



Fire Started	Vineyard burnt	Smoke drifted	Pre-veraison	Single fire	Sampled
20th Dec 2019	Around 1,000 ha	Intense smoke for 48 hours	Peppercorn sized berries	Fire contained in January 2020	**Mid-January** and **March**

Effect of smoke on post-veraison grapes

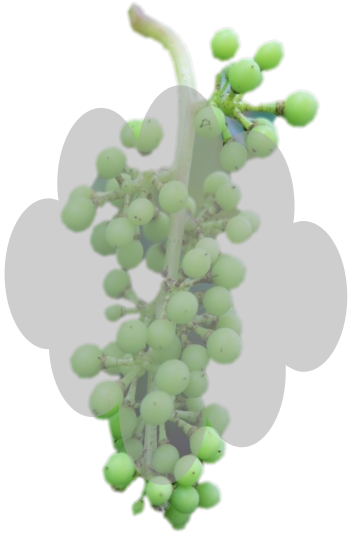
Post veraison grape smoke exposure



Smoky flavour

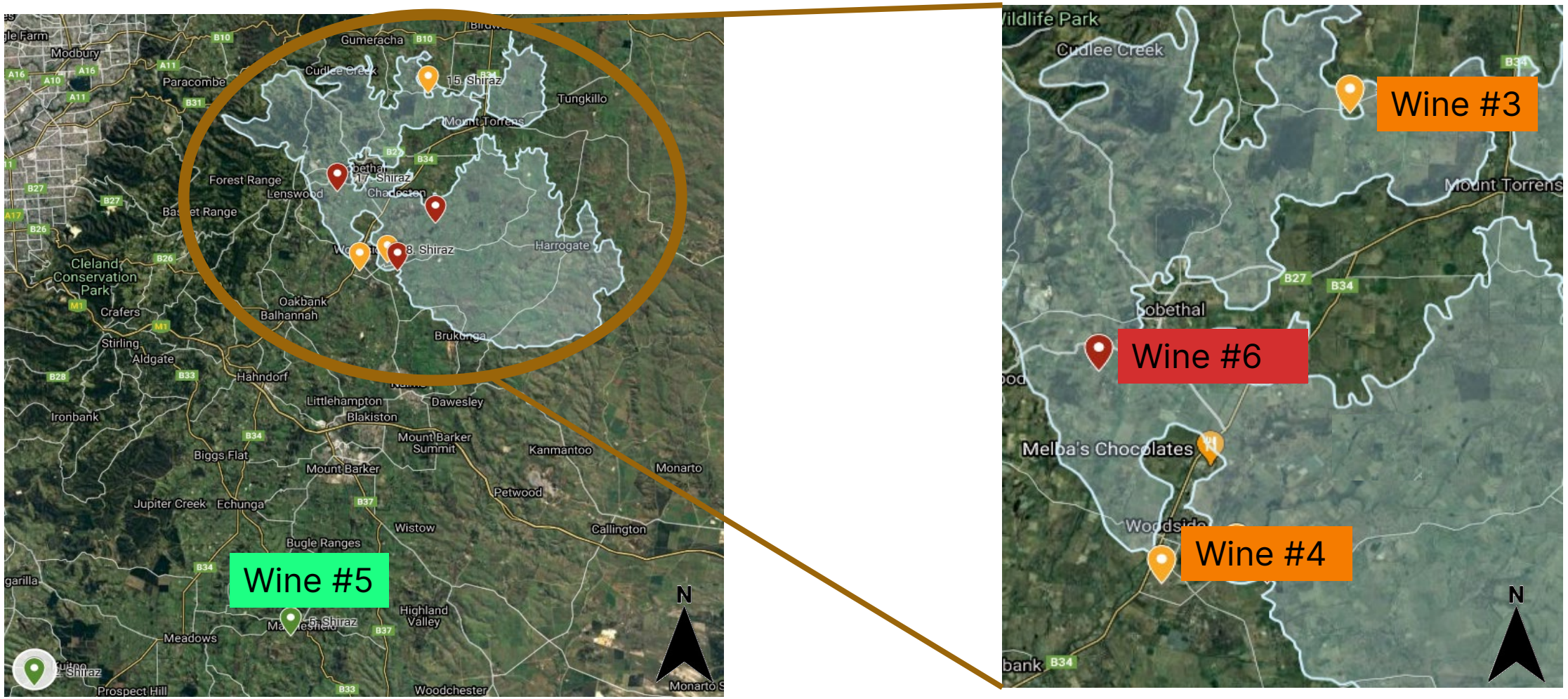
Effect of smoke on pre-veraison grapes

Unripe grape smoke exposure

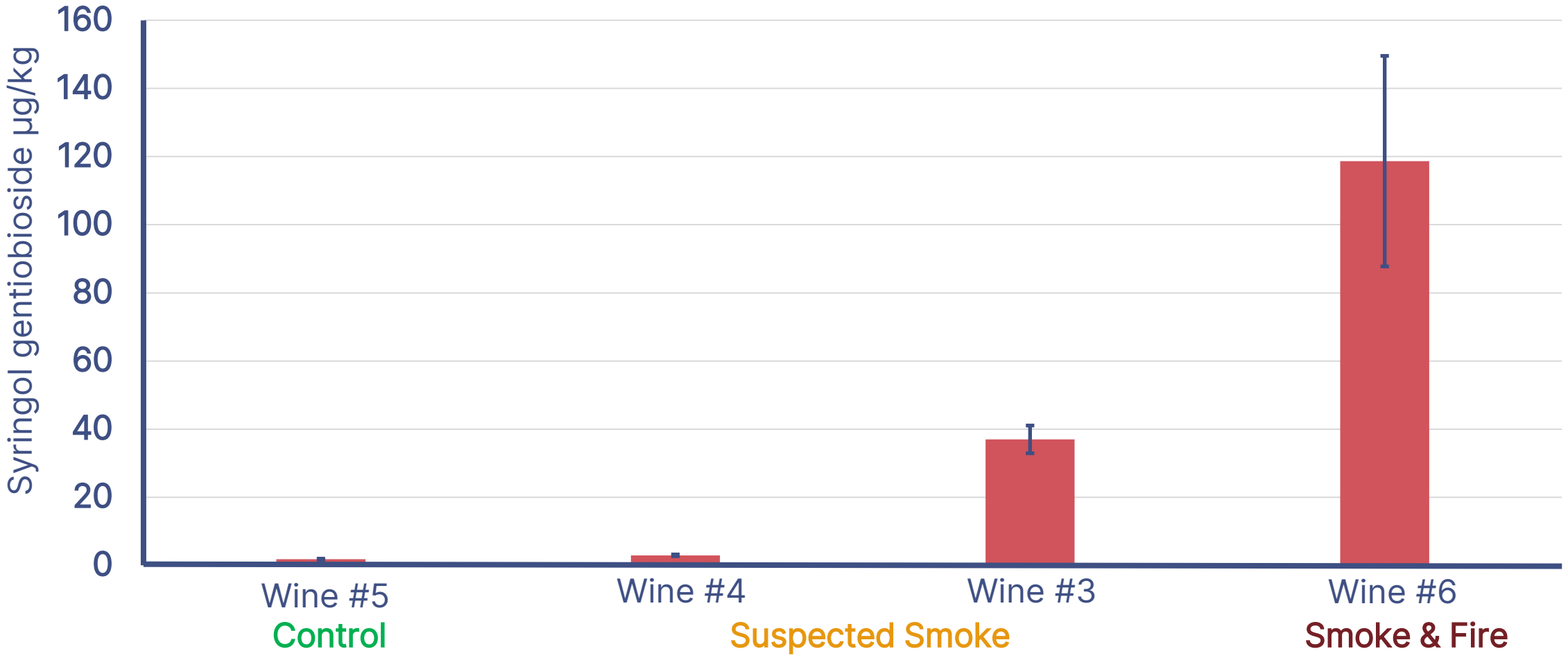


- Small berries
- Less sugar
- Unknown metabolism
- Change as the berries ripened
- Sensory effect

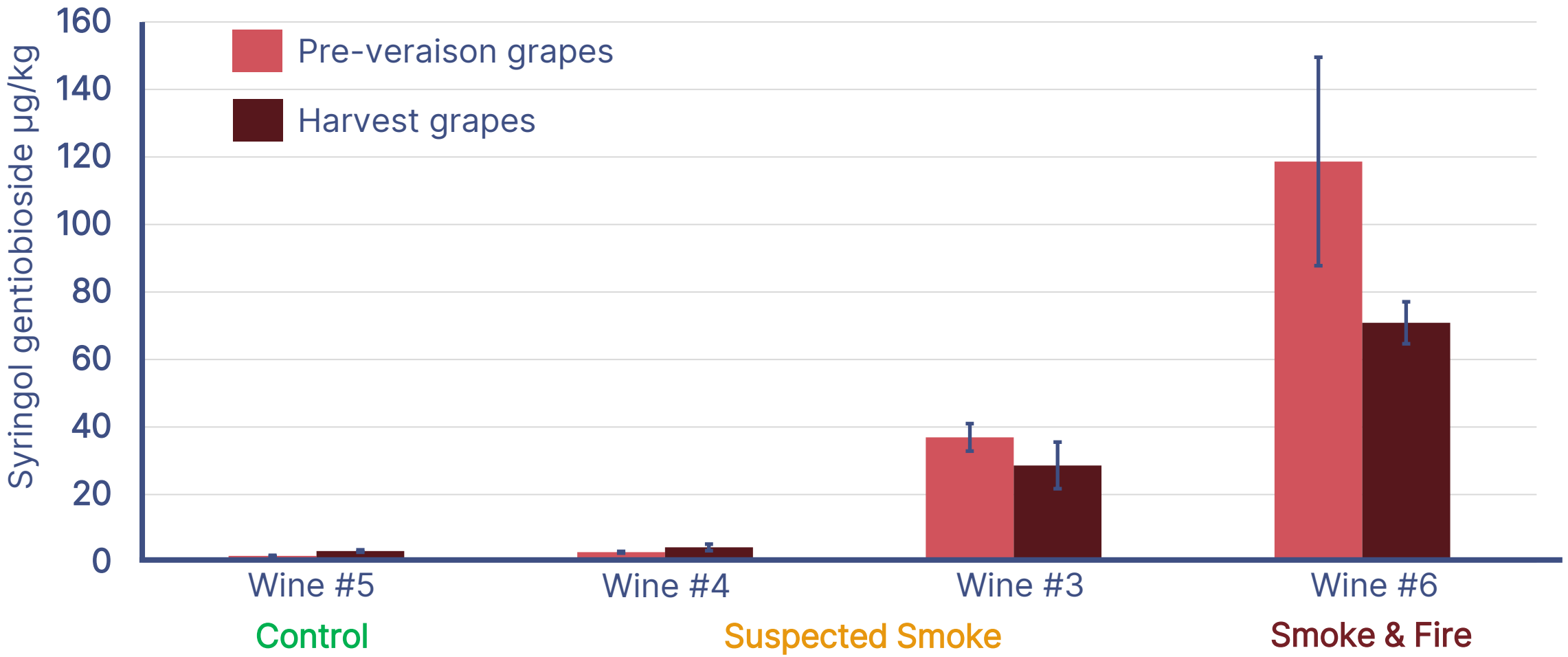
Map of Shiraz trial sites



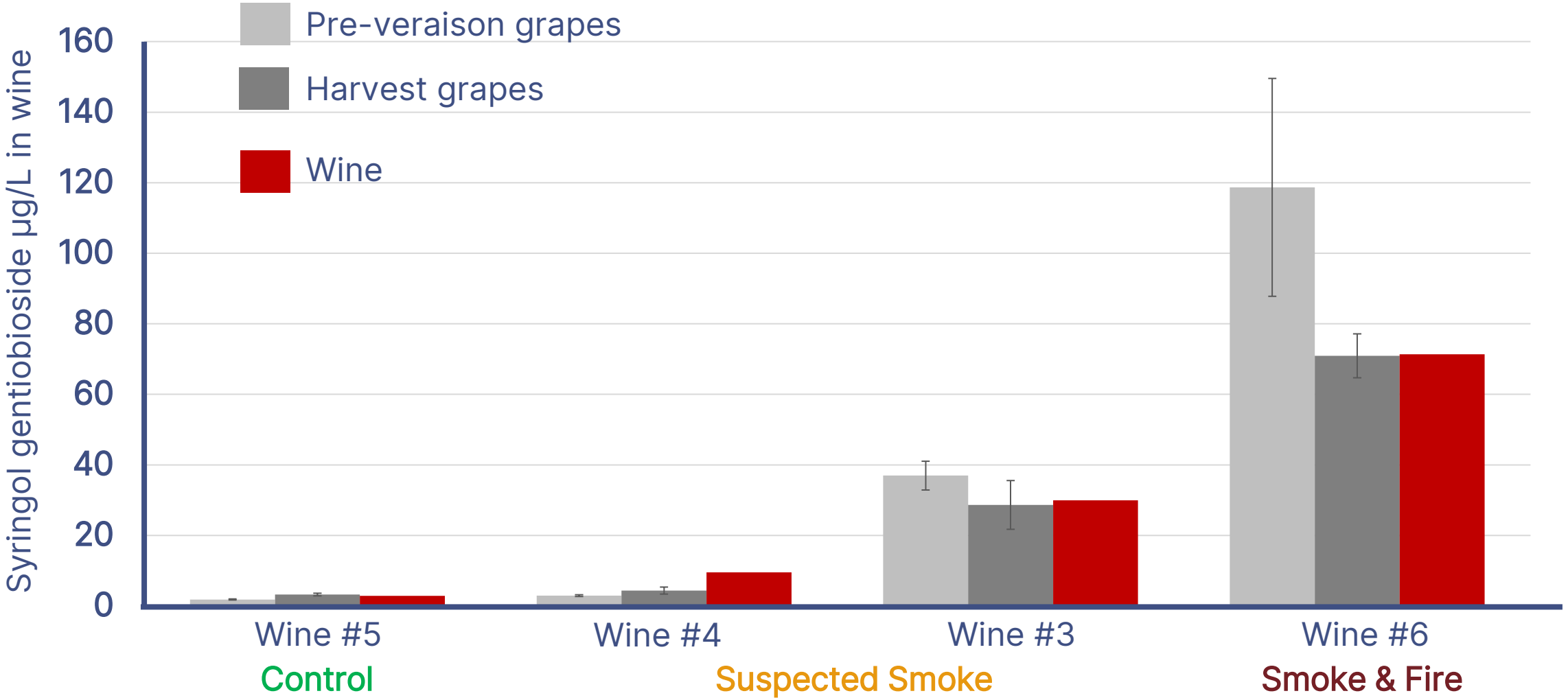
Smoke marker in pre-veraison grapes



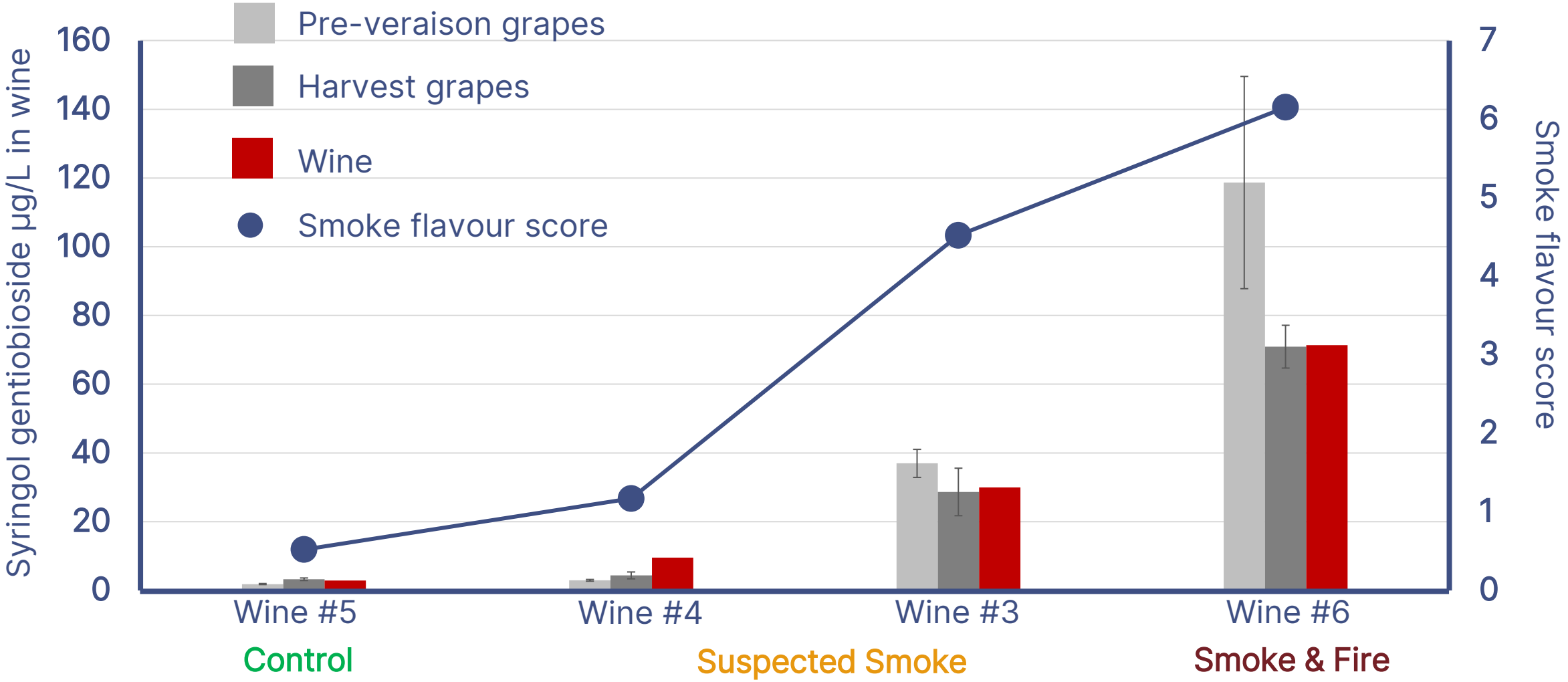
Smoke marker in pre-veraison and harvest grapes



Smoke marker and flavour rating in wine



Smoke marker and flavour rating in wine



How about Pinot Noir and Chardonnay?

Consistent across all varieties

- Glycosides formed in pre-veraison grapes
- Glycosides remained in the grapes at harvest
- Similar ranking of vineyards by SyGG

Something different

- Actual concentrations varied across varieties
- Increase of smoke marker glycosides from pre-veraison to harvest

Grape volatile phenols at trace level at pre-veraison but elevated in harvest for all varieties

Take home message

- Early season smoke poses risk to wine quality
- Variation according to smoke pattern –get tested!
- Be prepared to manage the risk of early season smoke

Smoke flavour:
linking chemical composition and sensory properties in smoke-affected wines

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Linking smoke flavour to grape and wine composition

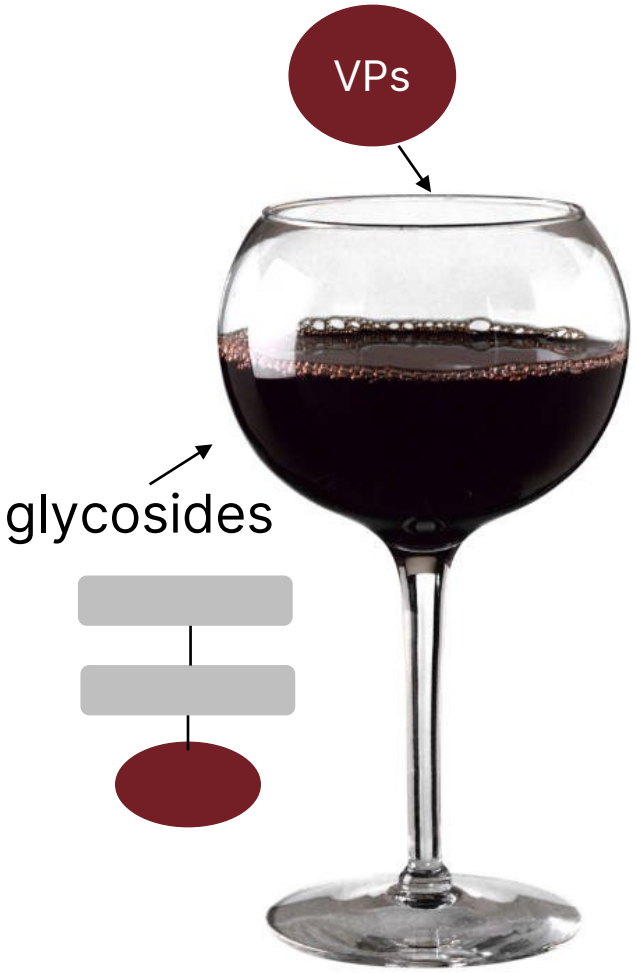
Grapes collected

- Chardonnay, Pinot Noir and Shiraz (n=63)

Wines produced

- No remediation treatments applied
- Sensory assessment of **'smoke' flavour** by AWRI panel
- 6 weeks to 21 months in bottle

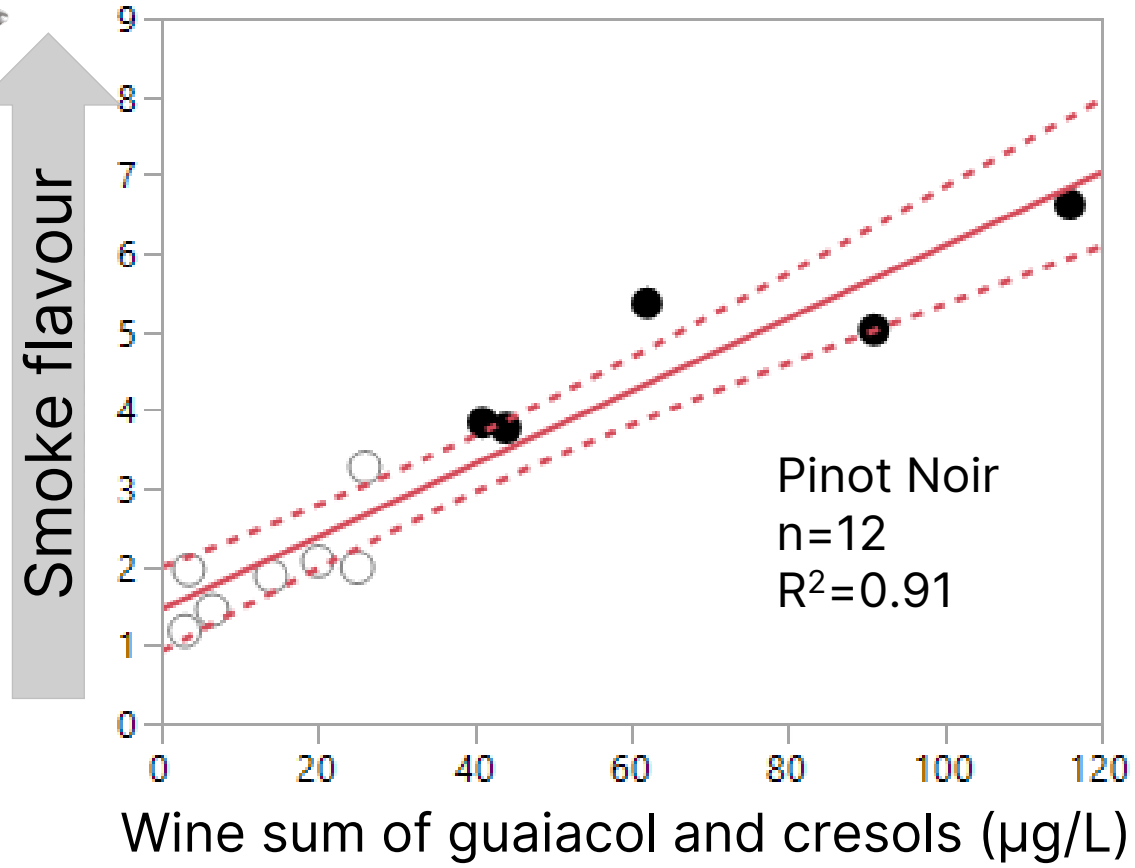
Linking **wine** compounds to smoke flavour



- Good predictive models (PLS, R^2>0.93)
- High degree of correlation among compounds
- **Subset of VPs and Glycosides** were most important
  - **guaiacol, *m*-cresol**, *o*-cresol, *p*-cresol, guaiacol rutinoside and cresol rutinoside
- Syringol and syringol gentiobioside were not important to model smoke flavour

➢ Are still good biomarkers of exposure

Linking **wine** compounds to smoke flavour



The sum of **(guaiacol + *m*-cresol + *o*-cresol + *p*-cresol) in wine**

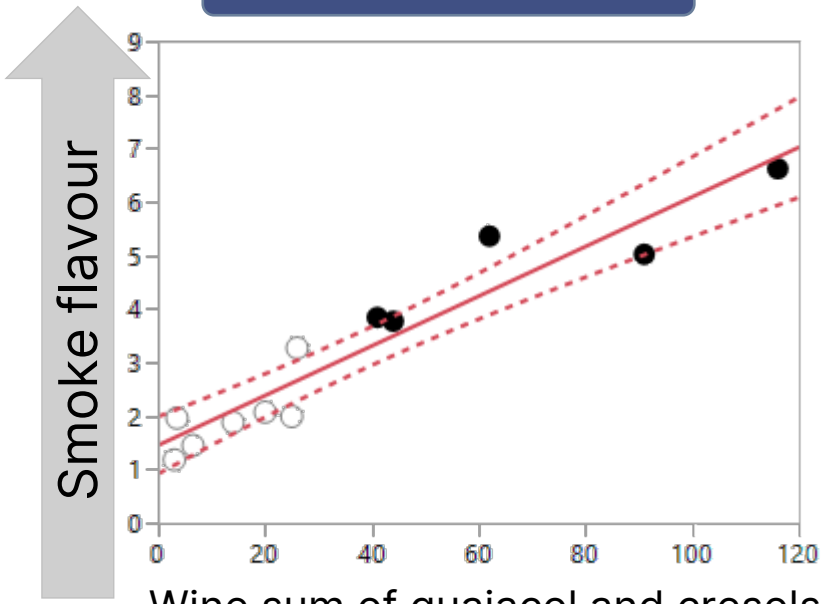
enabled very good prediction of **smoke flavour** intensity

even when compounds were below reported sensory thresholds

- ● Discernible smoke flavour
- ○ Not significant

Linking **wine** compounds to smoke flavour

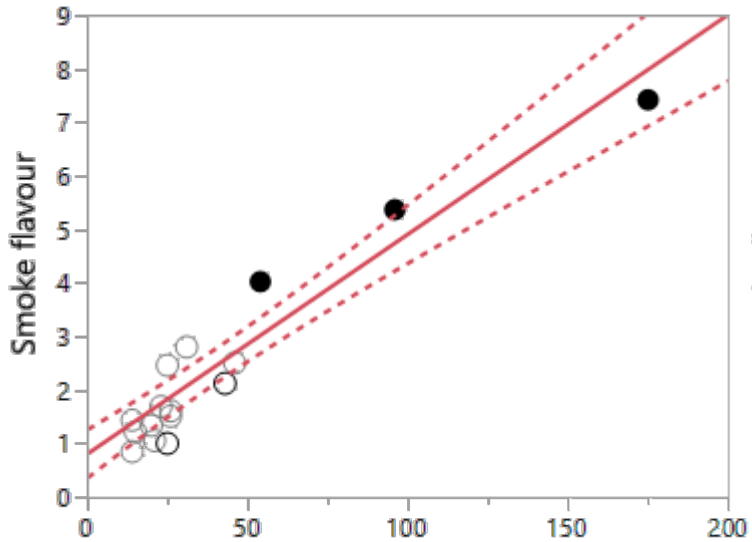
Pinot Noir



Wine sum of guaiacol and cresols (µg/L)

R^2=0.91
n=12

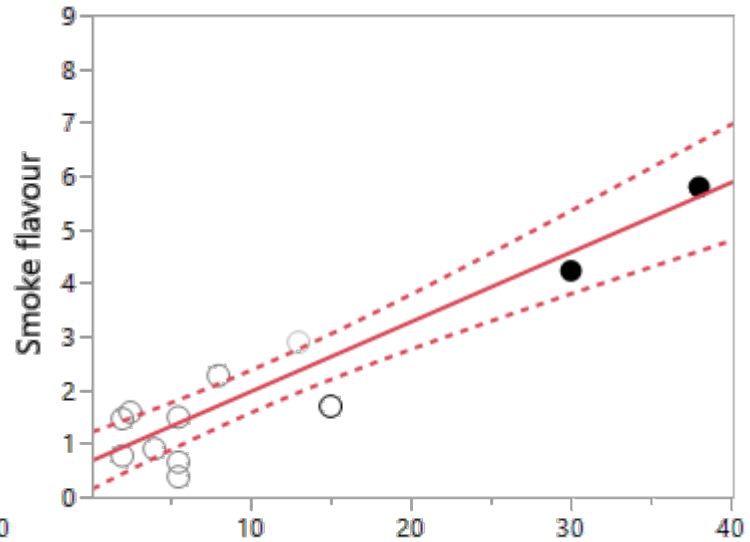
Shiraz



Wine sum of guaiacol and cresols

R^2=0.91
n=16

Chardonnay

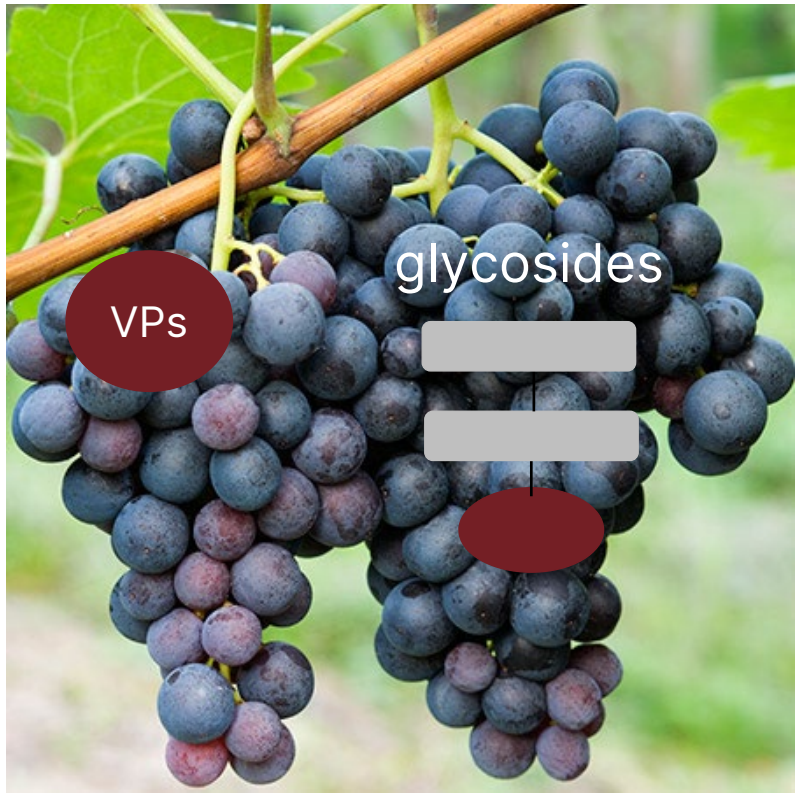


Wine sum of guaiacol and cresols

R^2=0.89
n=12

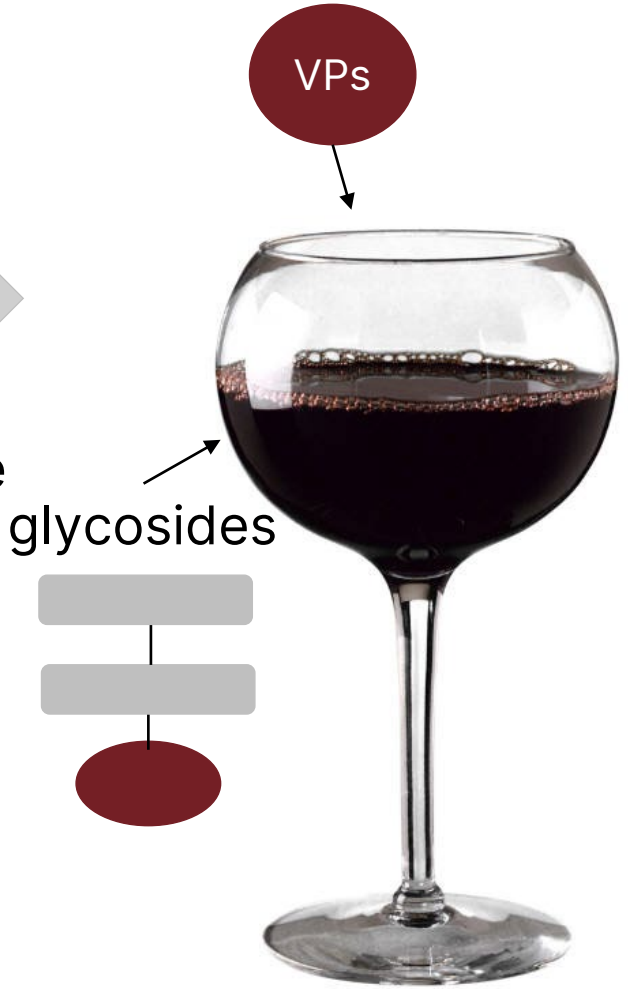
● Discernible smoke flavour ○ Not significant

Linking grape and wine composition



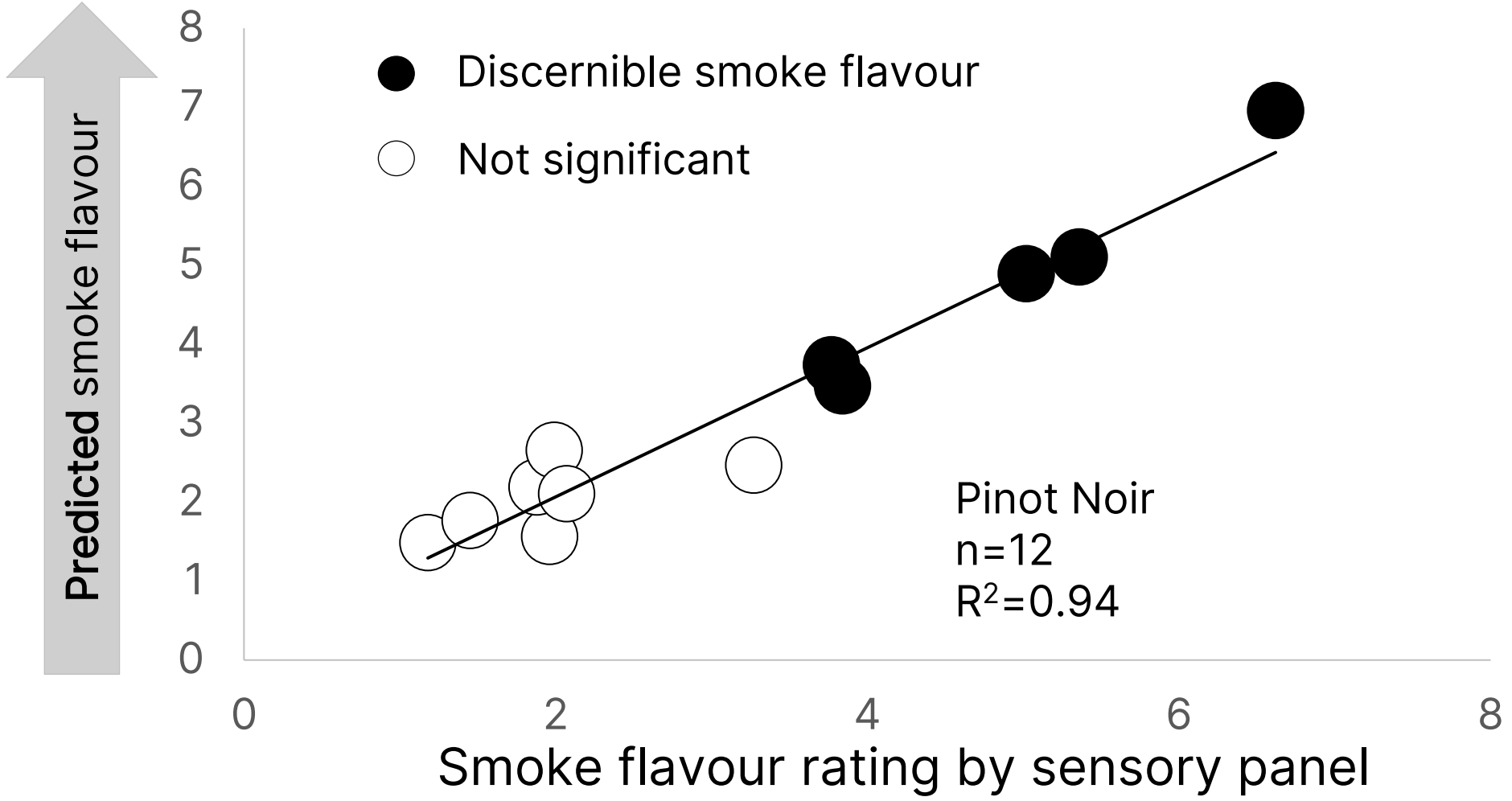
Variable proportion from grape to wine

especially Chardonnay



Predicting smoke flavour from **grape** markers

Smoke flavour predicted by a subset of Grape VPs and Glycosides



VPs

guaiacol
cresols

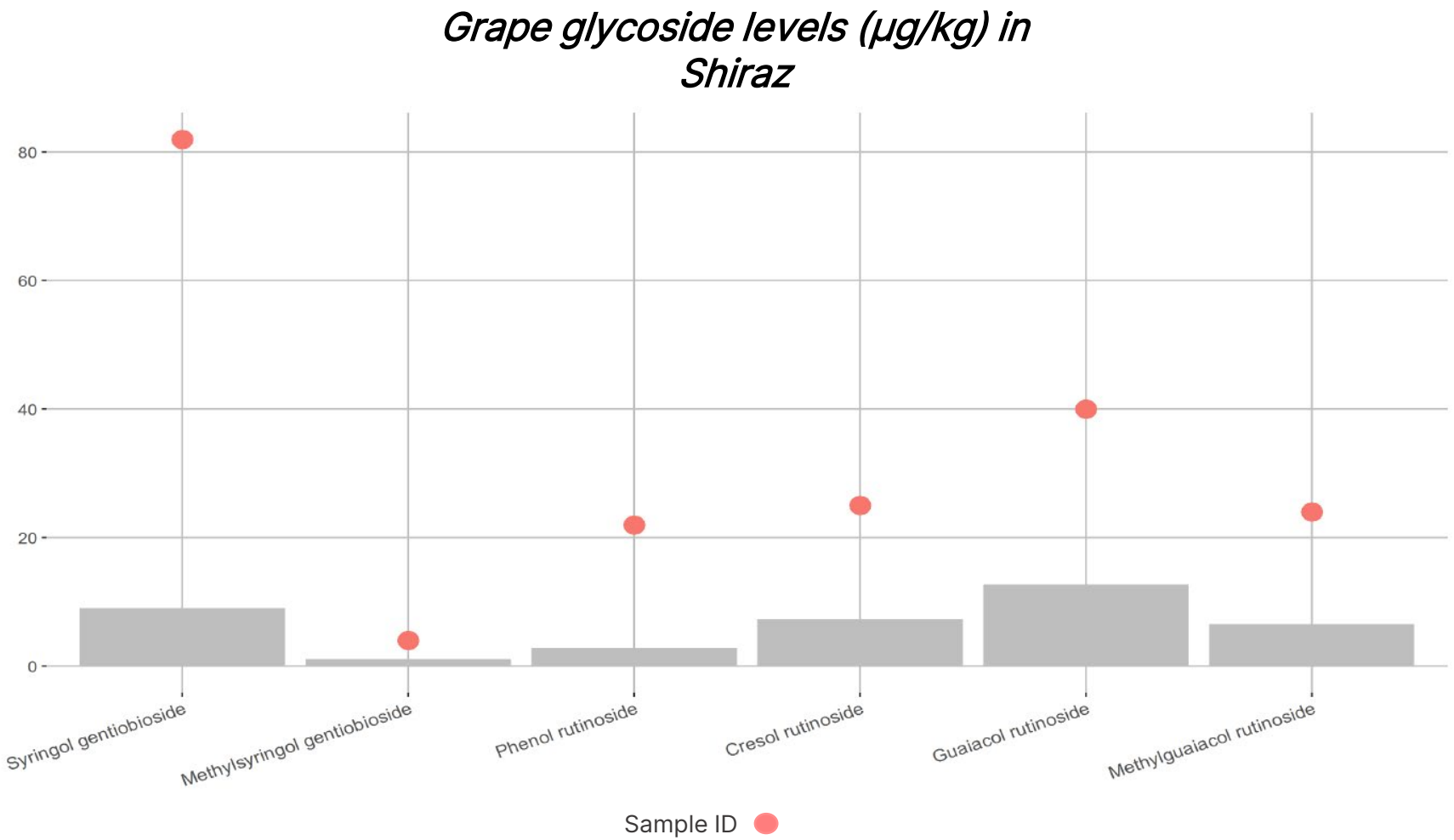
Glycosides
guaiacol rutinoside,
cresol rutinoside

SyGG not driving flavour
But reliable marker

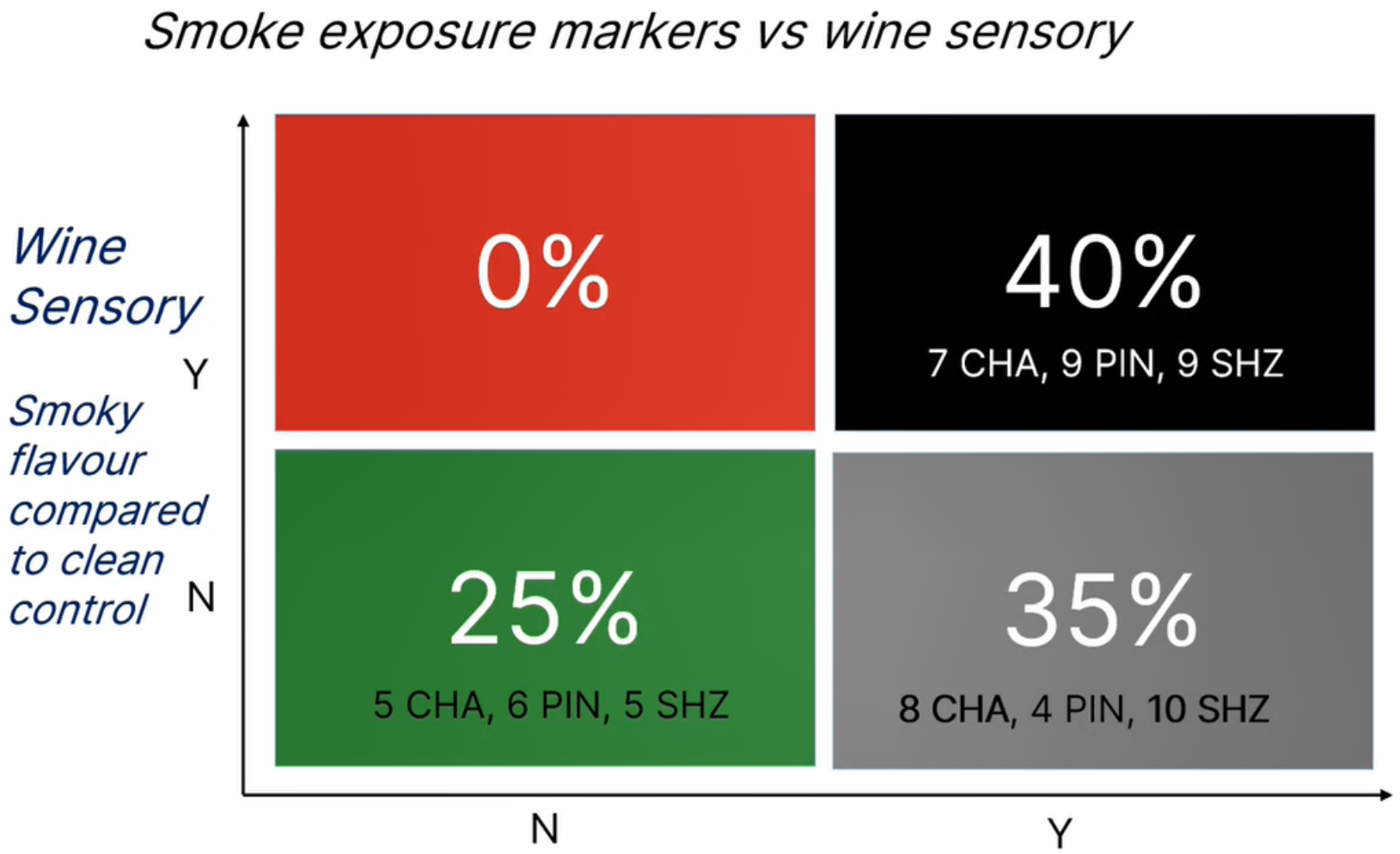
But how much is too much?

- Sensory –trained panel compared to clean controls
- Classified as ‘significant smoke flavour’ or not
- Chardonnay, Pinot Noir, Shiraz
- Data from two studies combined, altogether 63 wines
- Adelaide Hills pre-veraison smoke (23)
- SA, VIC, NSW, ACT various smoke events (40)
- Marker concentrations in grapes

Sample results vs background data



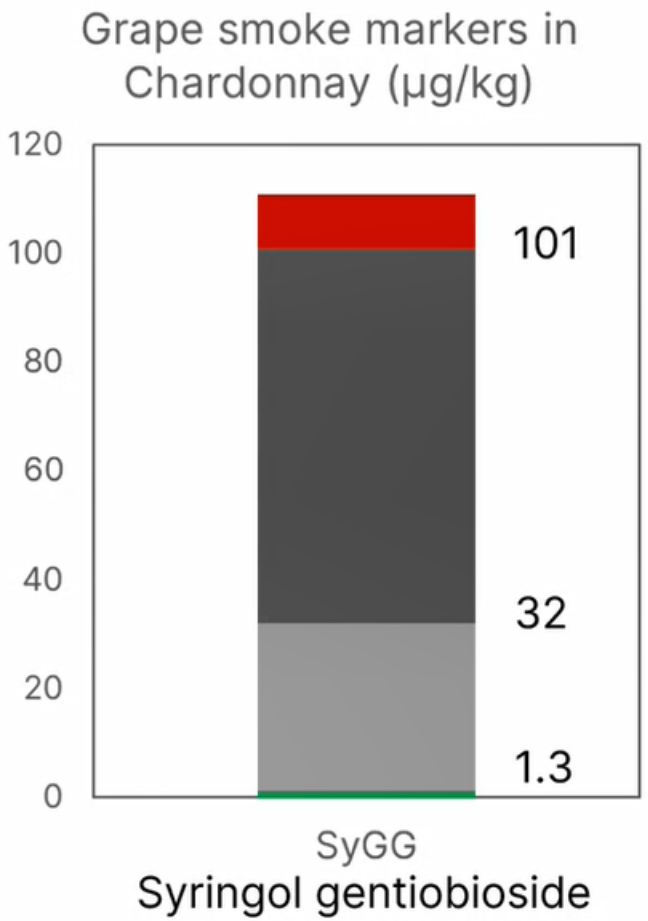
Smoke exposure vs smoke markers



63 wines x 3 time points

SA, Vic, NSW
Cha, Pin, Shz

Risk zones for grape markers



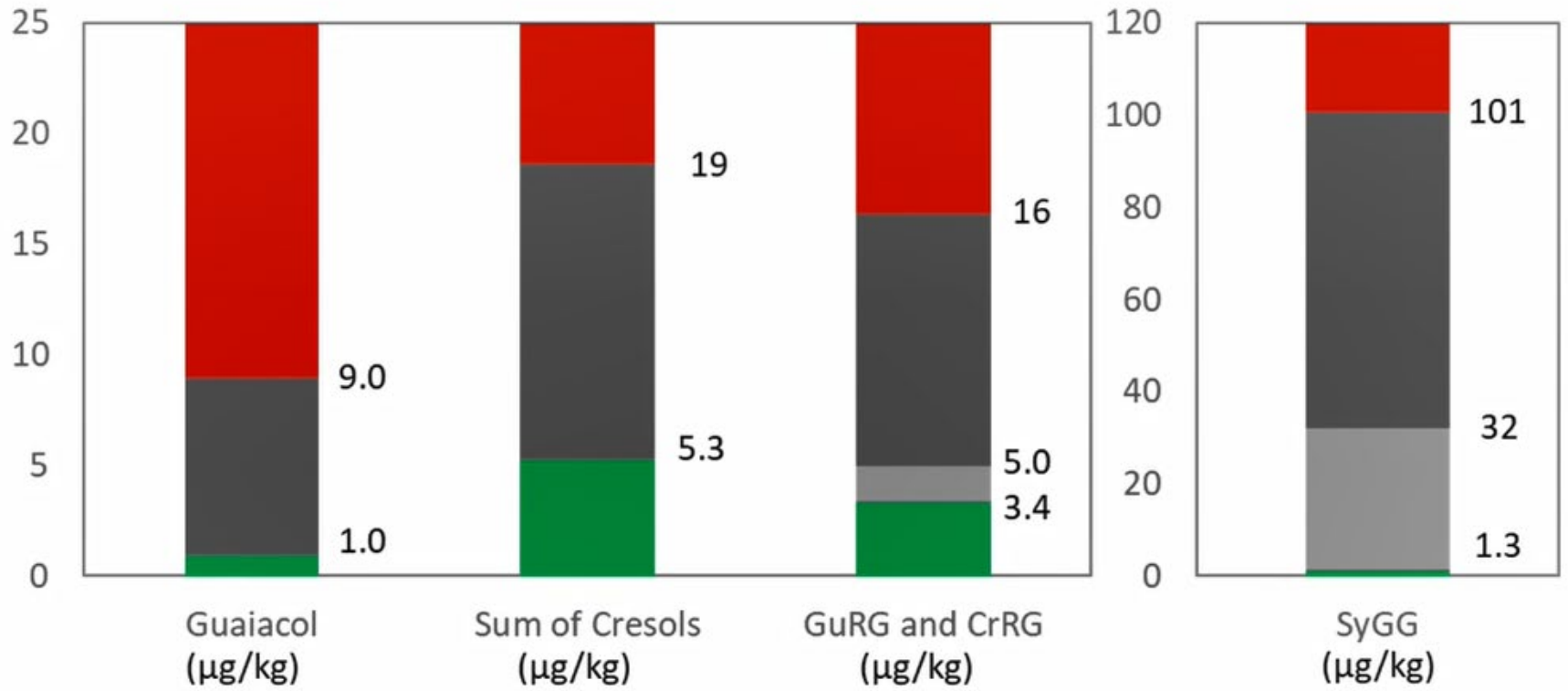
High risk: all wines had obvious smoke flavour.

Moderate risk: some wines, but not all, had obvious smoke flavour.

Low risk: no wines observed with obvious smoke flavour.

Baseline –upper limit of values seen in grapes with no smoke exposure.

Risk zones for key smoke exposure markers in Chardonnay grapes



Likewise for Pinot Noir and Shiraz

Summary

- Consumer and sensory linked back to grape composition
- Chardonnay, Pinot Noir and Shiraz
- Goal: avoid awful wine
    - And avoid unnecessary crop losses

Acknowledgements

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Wine Victoria
Wine Australia

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