Smoke Taint
– The latest research from the AWRI

AWRI Australian Wine Research Institute

Mango Parker & Adrian Coulter

Lignin, volatile phenols and phenylpropanoid pathway

Phenylpropanoid pathway

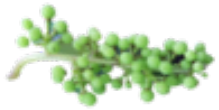
- Responsible for biosynthesis of a huge amount of secondary metabolites (including flavonoids and lignins)

- Phenylpropanoids are often correlated with the plant's stress management strategies that are also regulated by **glycosylation**

    - Phenylpropanoid homeostasis (glycosylation and de-glycosylation)

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?

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. https://www.mdpi.com/1420-3049/26/11/3187

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. https://doi.org/10.1111/ajgw.12543

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.* *https://www.hindawi.com/journals/ajgwr/2022/9820204/*

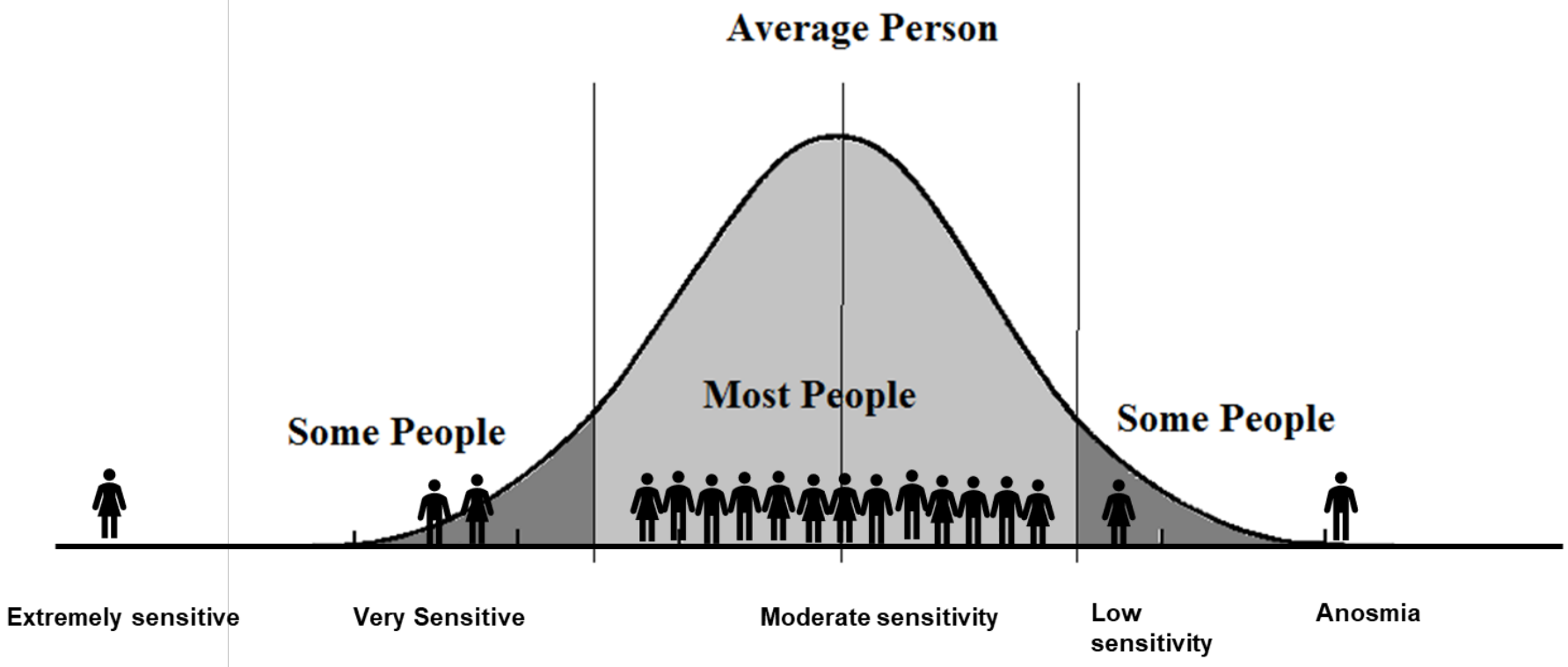
Bilogrevic, E., Jiang, W., Culbert, J., Francis, L., Herderich, M. and Parker, M. **2023**. Consumer response to wine made from smoke-affected grapes. *Oeno One*, 57 (2): 417-430. https://oeno-one.eu/article/view/7261

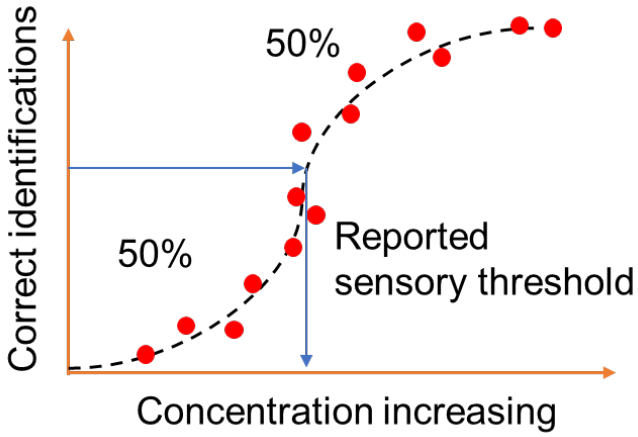
Parker, M., Jiang, W. M., Bilogrevic, E., Likos, D., Gledhill, J., Coulter, A. D., Cowey, G. D., Simos, C. A., Francis, I. L. and Herderich, M. J. **2023**. Modelling Smoke Flavour in Wine from Chemical Composition of Smoke-Exposed Grapes and Wine. *Aust. J. Grape Wine Res.*, 2023: 1-14. https://www.hindawi.com/journals/ajgwr/2023/4964850/

Glass 1: Guaiacol glucoside

Glass 2: *m*-Cresol glucoside

Variation in sensitivity





The consumer response to smoke exposed wines

Recruitment Criteria

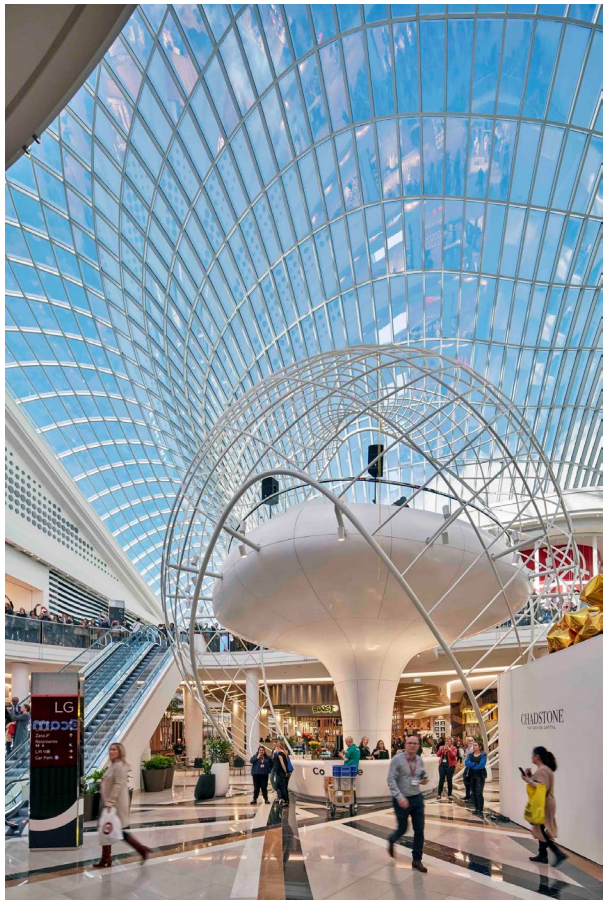
- Regular **red/white/rosé** wine drinkers
- 50% females, 50% males (except for the Rosé study)
- Ranging from 18-65 years old
- Make at least 50% of the wine purchase decisions
- Spend more than $10 on red wine purchases

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.

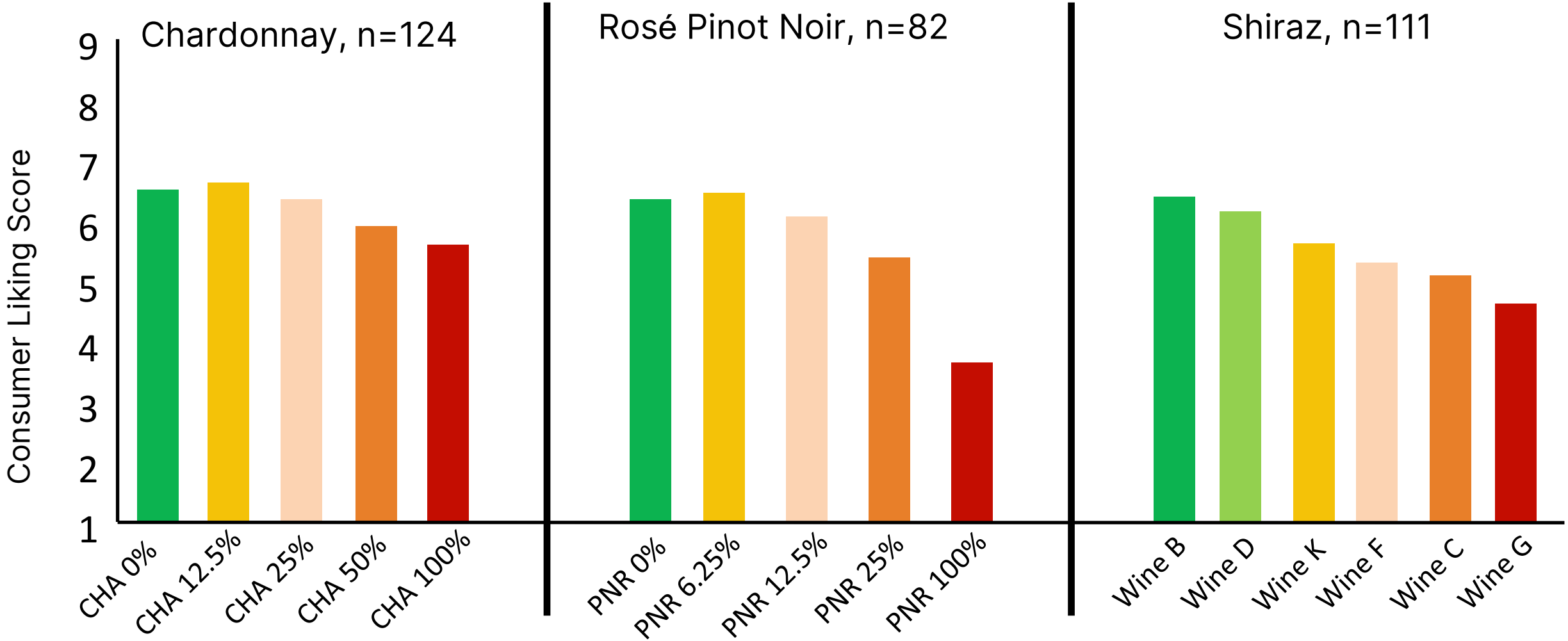
- ☐ Like Extremely
- ☐ Like Very Much
- ☐ Like Moderately
- ☐ Like Slightly
- ☐ Neither Like nor Dislike
- ☐ Dislike Slightly
- ☐ Dislike Moderately
- ☐ Dislike Very Much
- ☐ Dislike Extremely

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

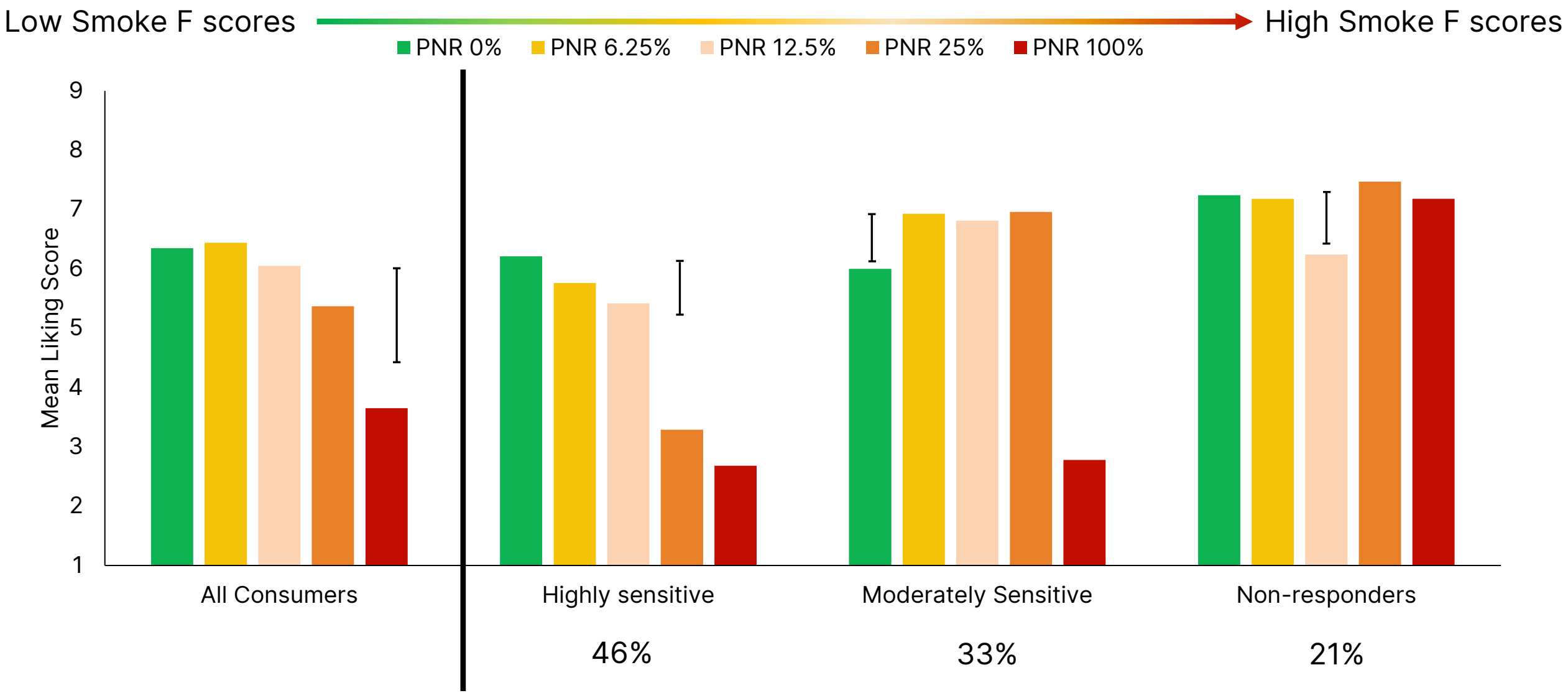
Glasses: randomised order

Consumer response to smoke affected wines

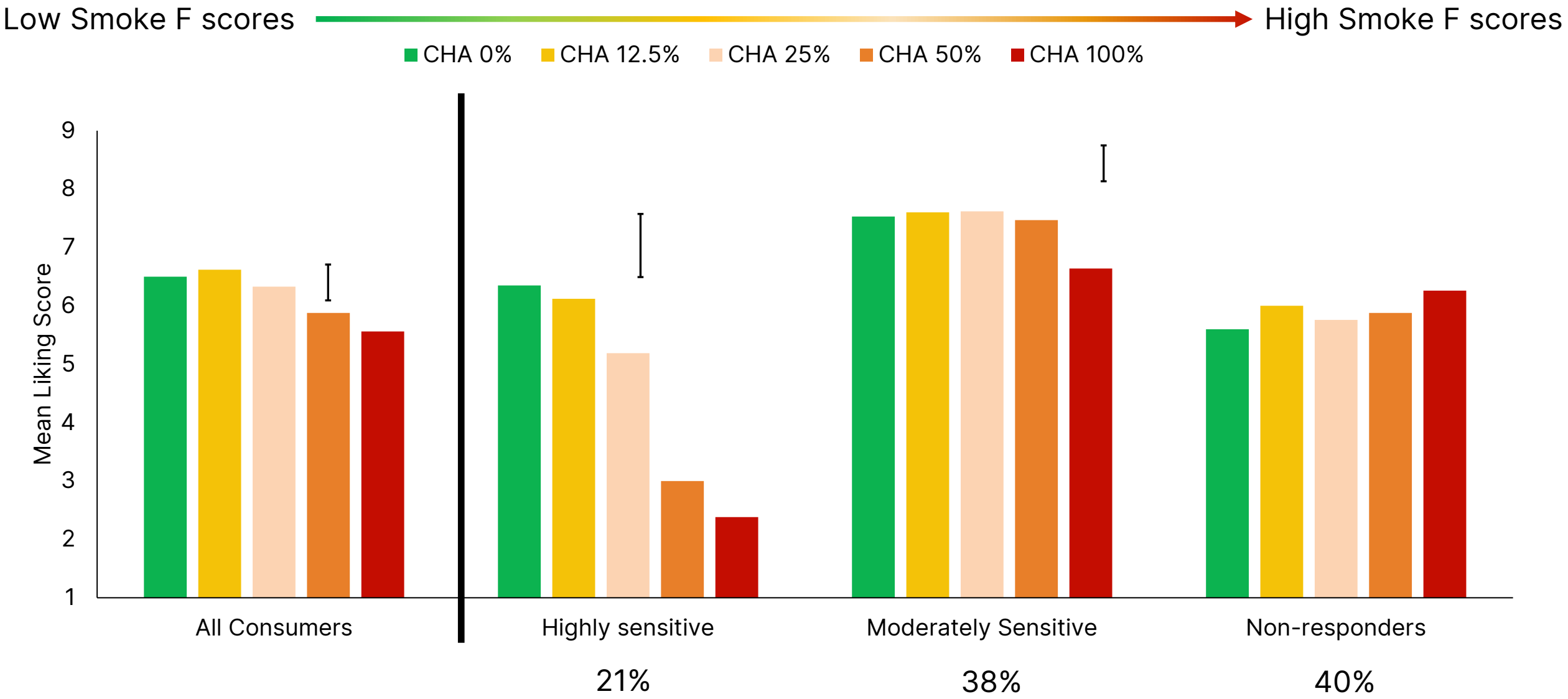
Low Smoke F scores → High Smoke F scores



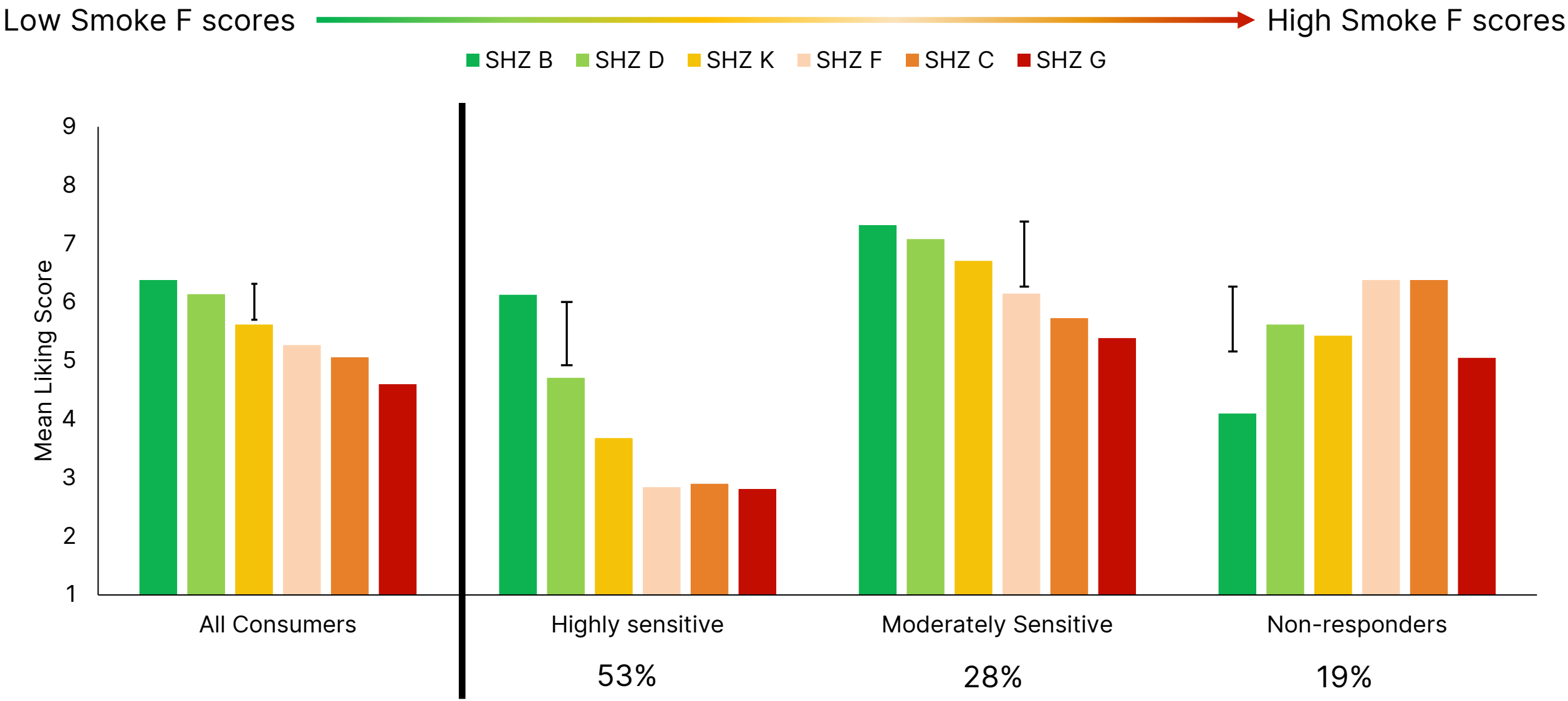
Pinot Noir Rosé - Liking Data (n=82)



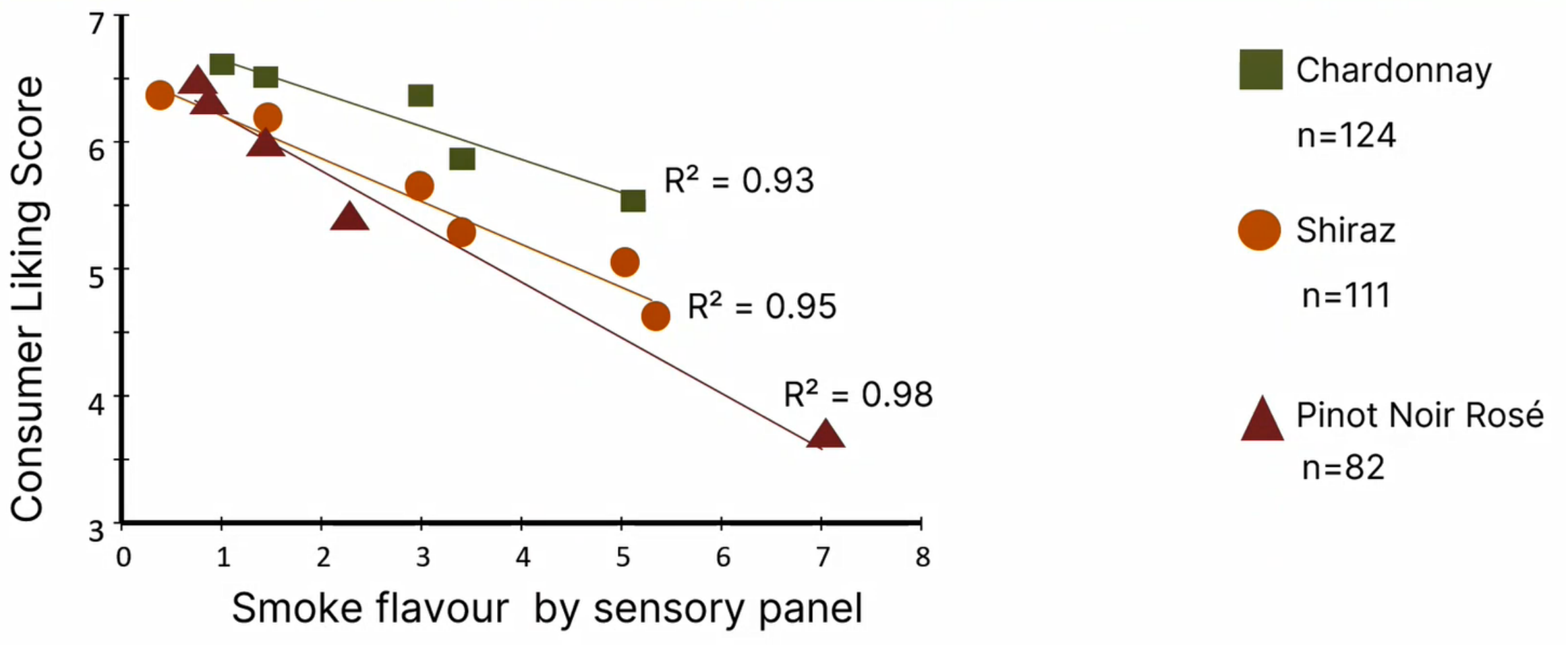
Chardonnay - Liking Data (n=124)



Shiraz - Liking Data (n=111)



Consumer liking and smoke flavour



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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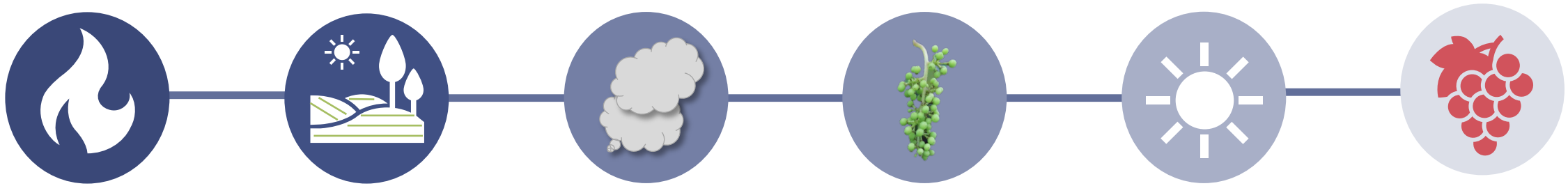
Photo: Peter Leske

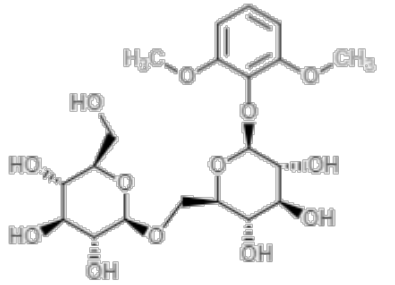
Brief history of 2019 Cudlee Creek fire event



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

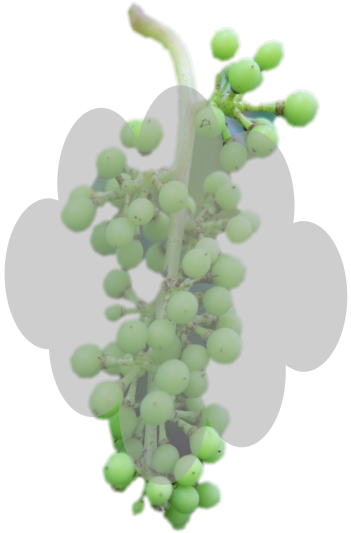
Post veraison grape smoke exposure



Smoky flavour

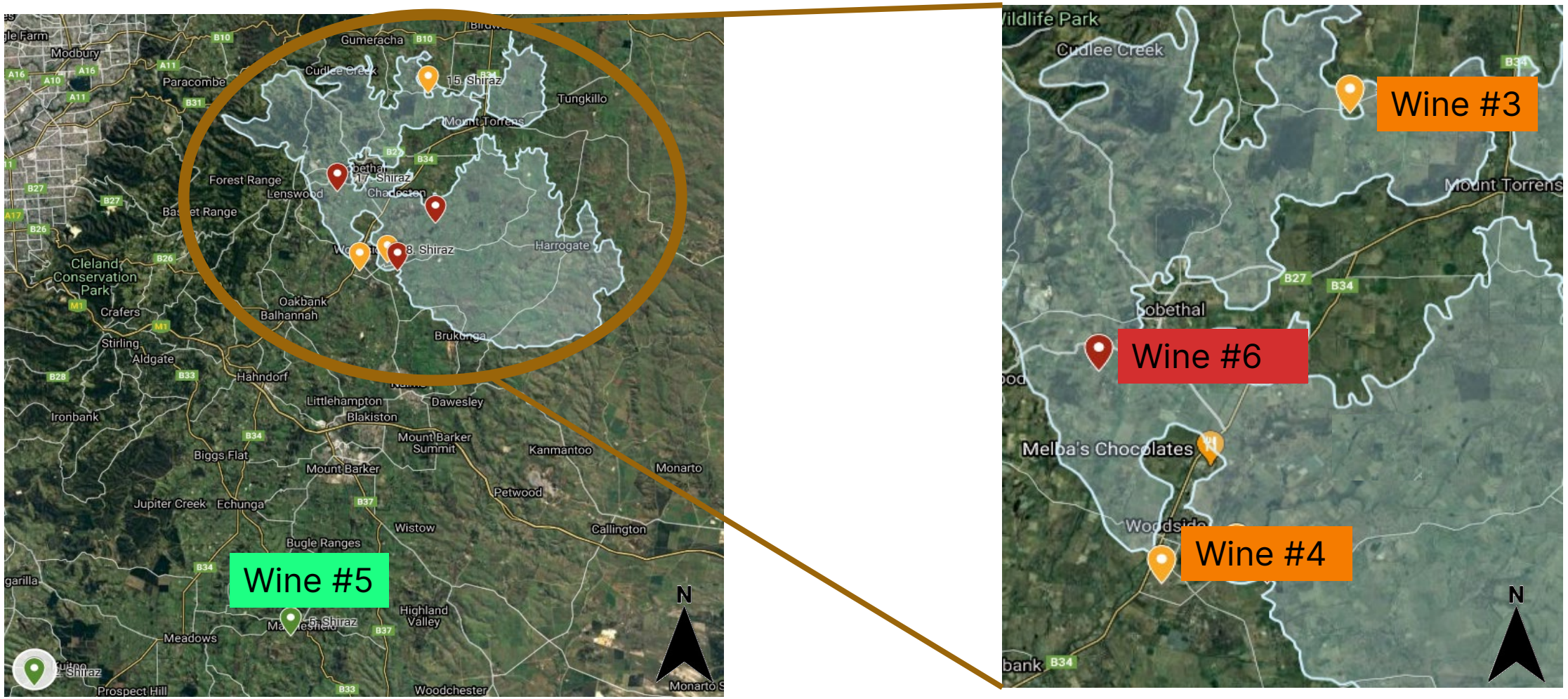
Effect of smoke on pre-veraison grapes

Unripe grape smoke exposure

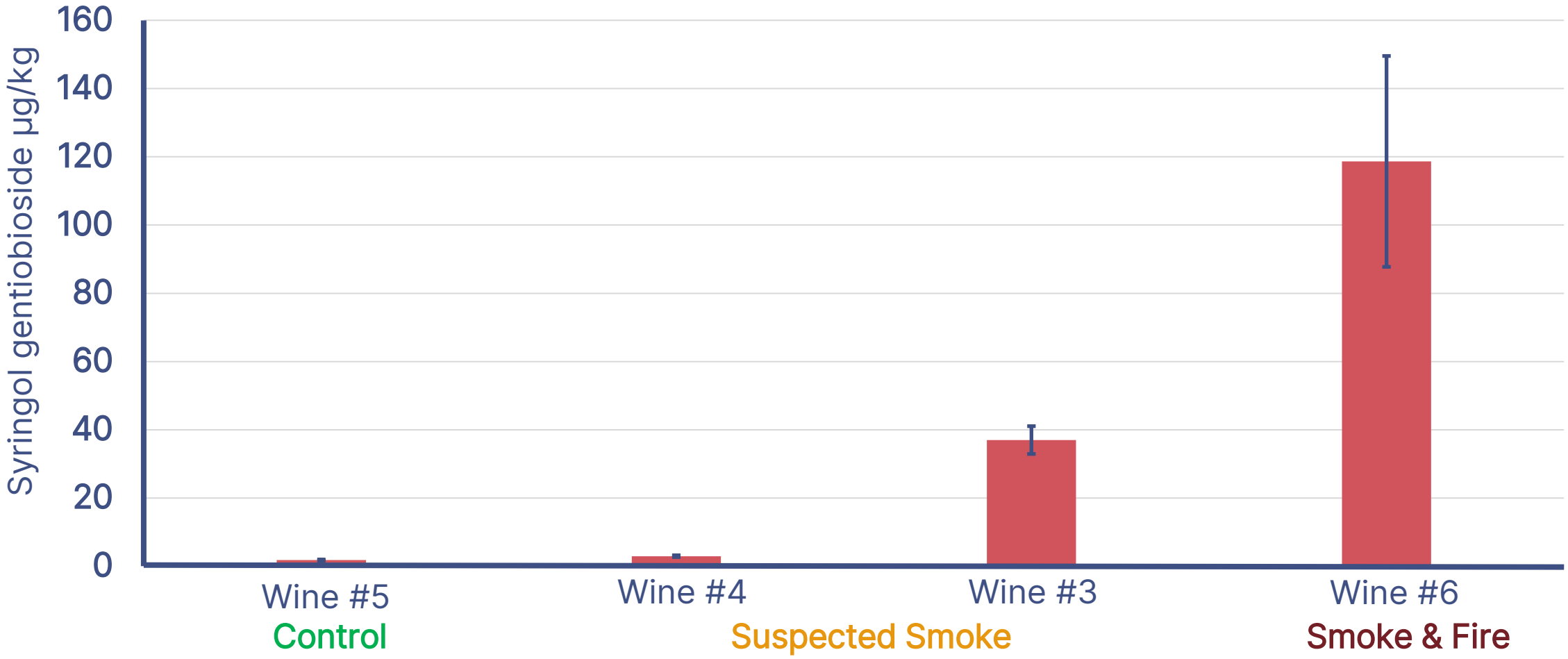


- Small berries
- Less sugar
- Unknown metabolism
- Change as the berries ripened
- Sensory effect

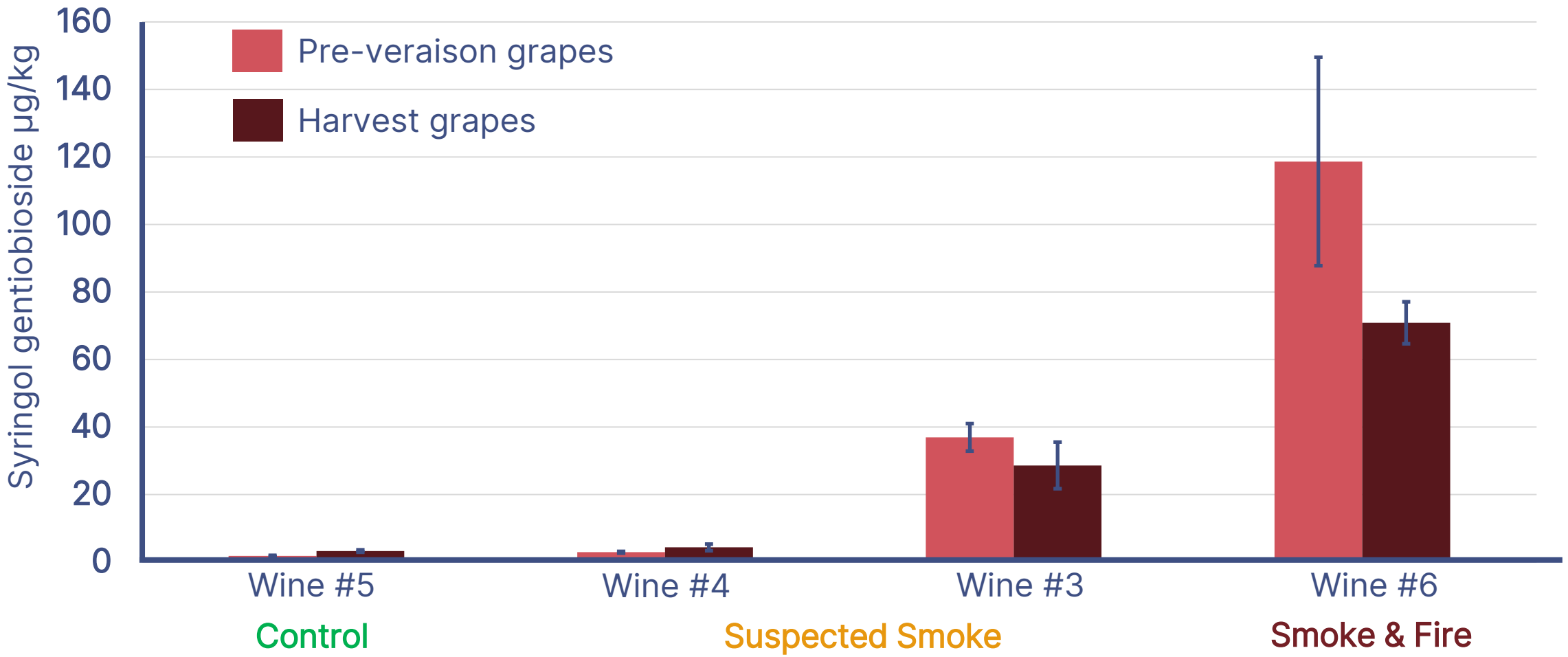
Map of Shiraz trial sites



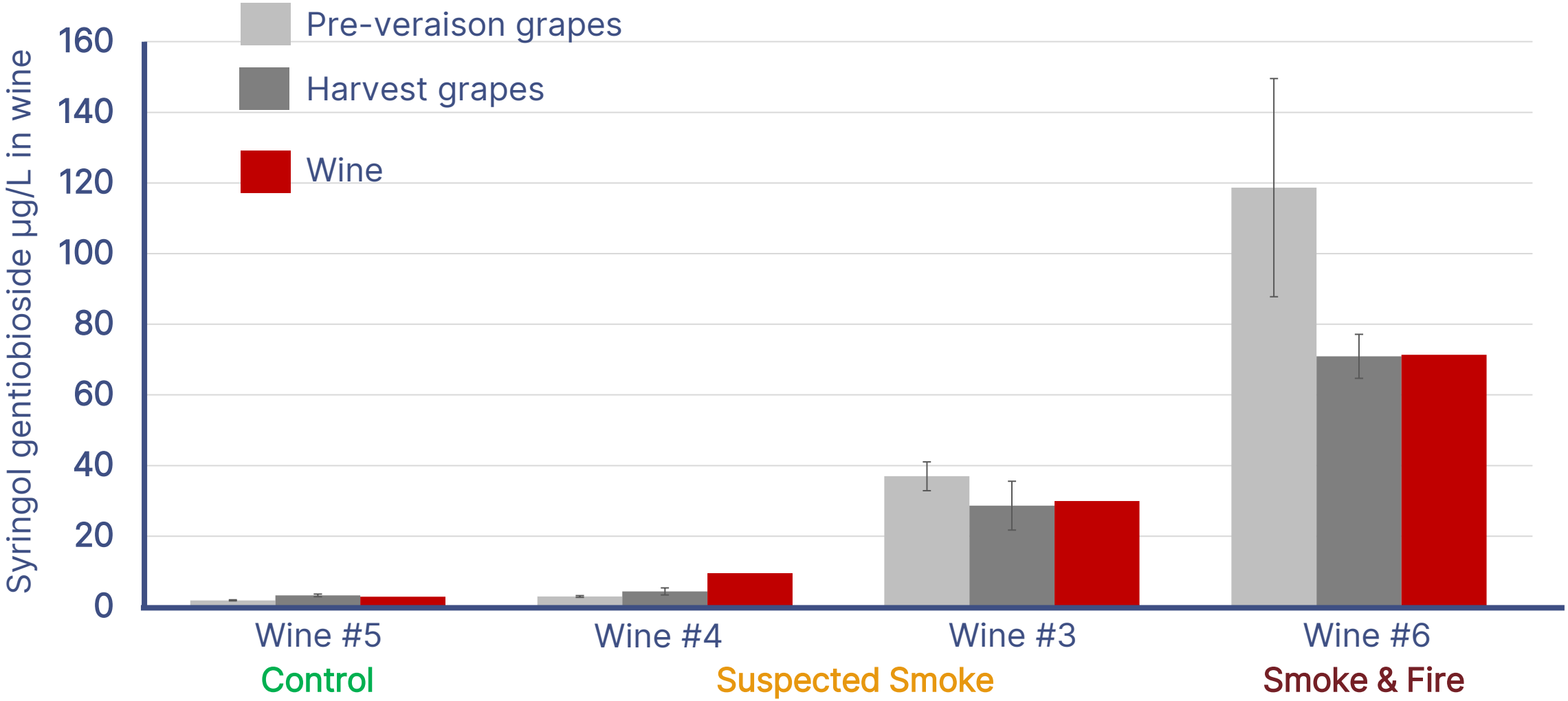
Smoke marker in pre-veraison grapes



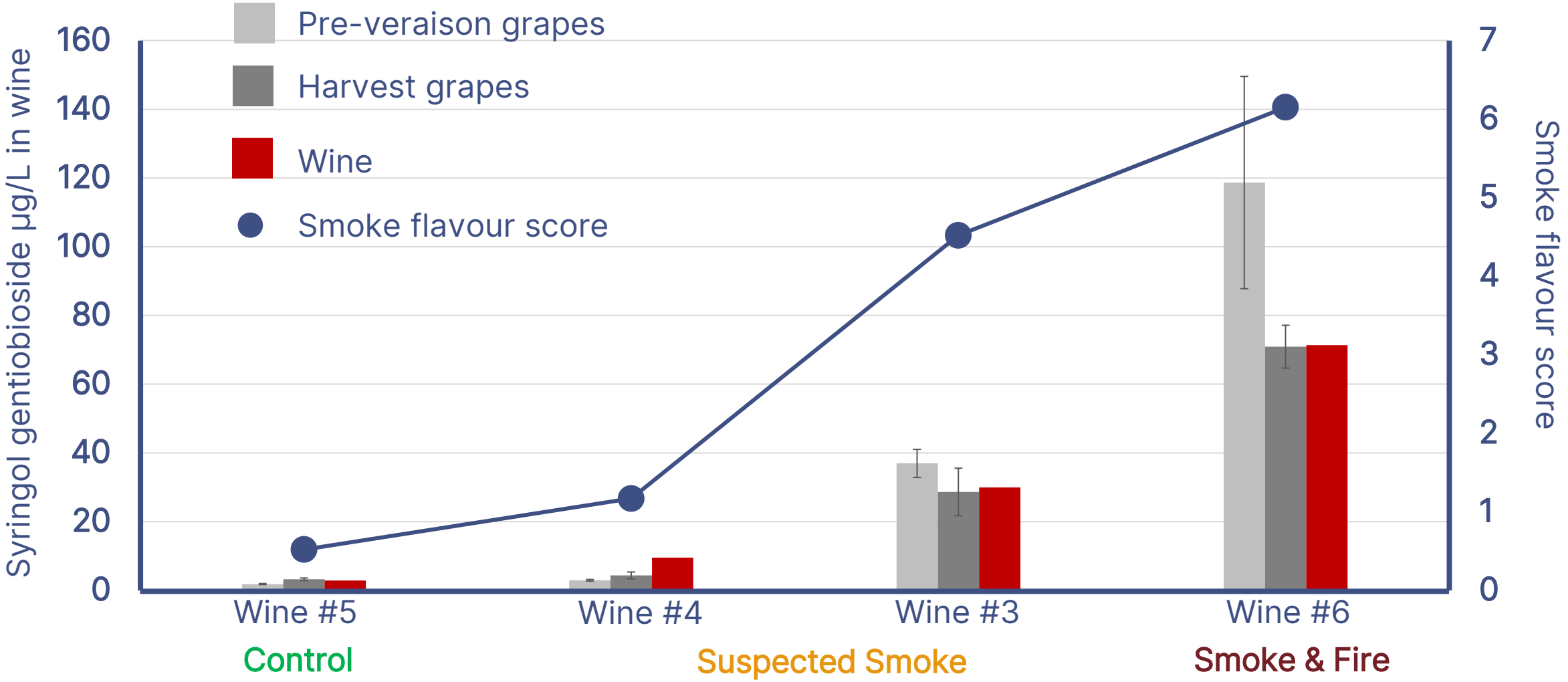
Smoke marker in pre-veraison and harvest grapes



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

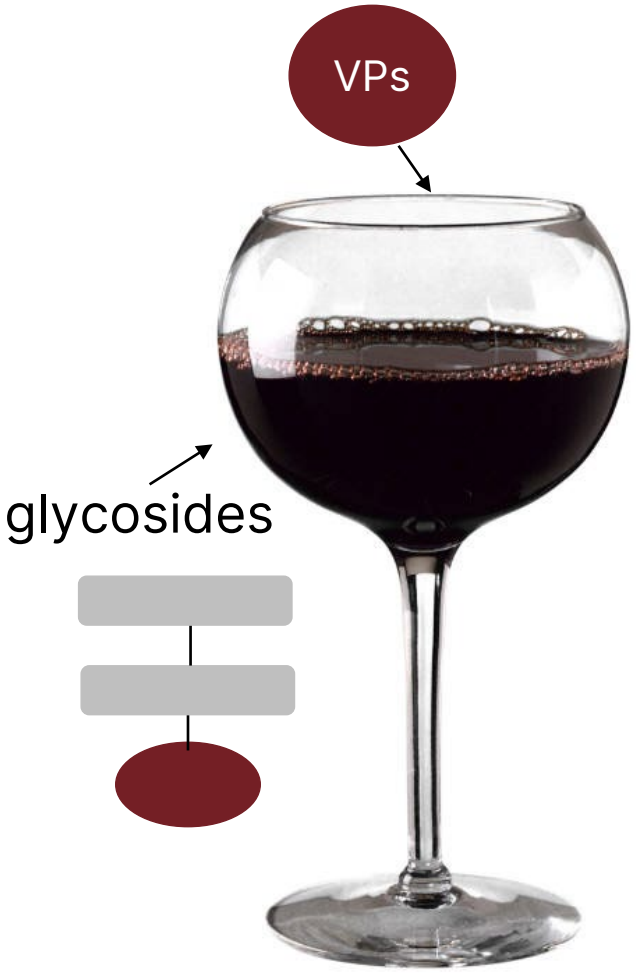
Grapes collected

- 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

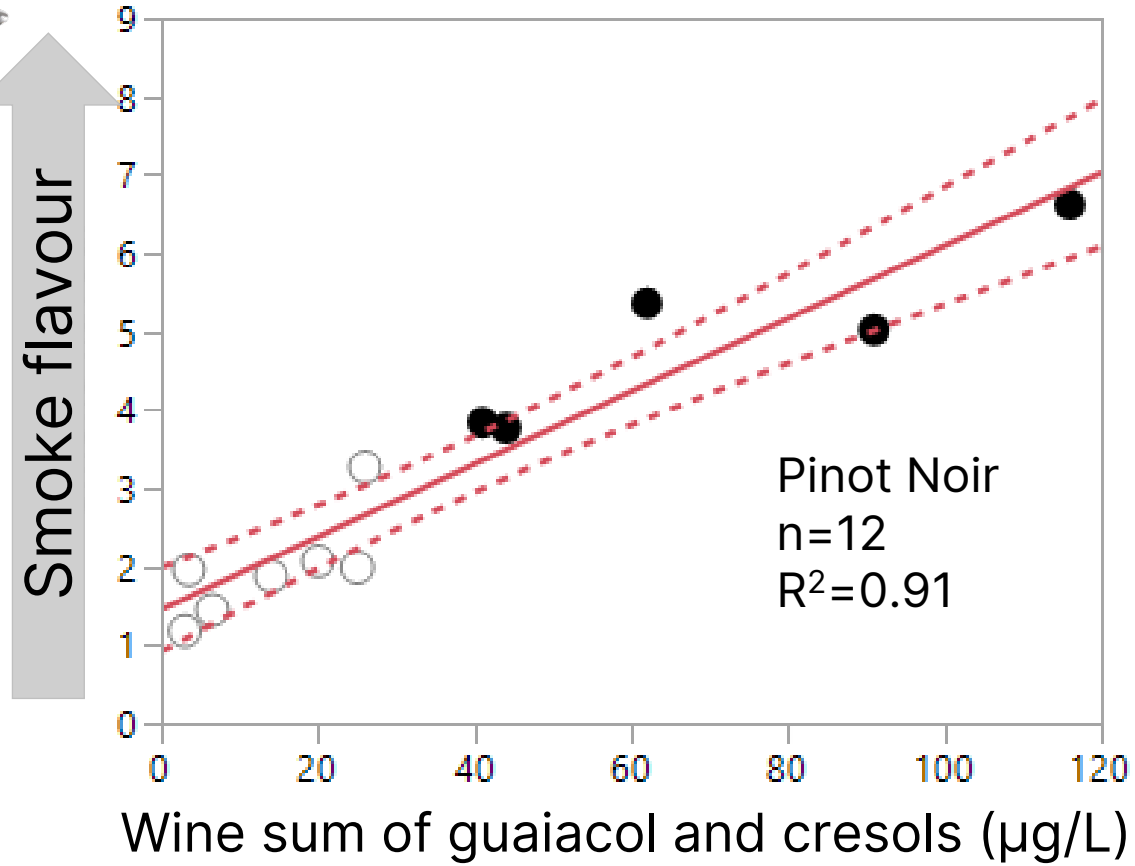
Linking **wine** compounds to smoke flavour



- 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**

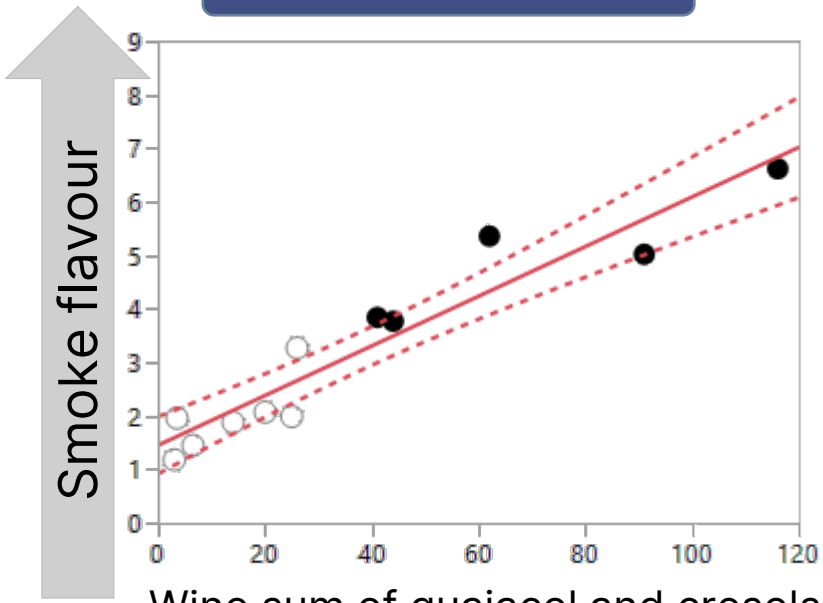
enabled very good prediction of **smoke flavour** intensity

even when compounds were below reported sensory thresholds

- ● Discernible smoke flavour
- ○ Not significant

Linking **wine** compounds to smoke flavour

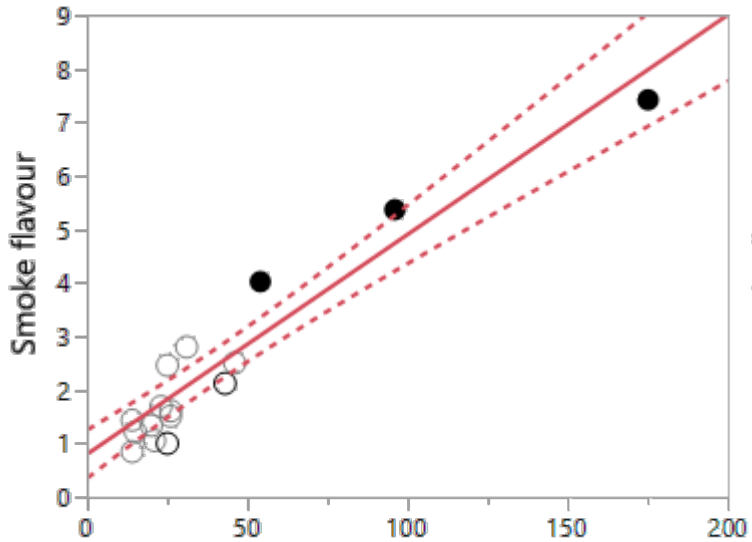
Pinot Noir



Wine sum of guaiacol and cresols (µg/L)

R^2=0.91
n=12

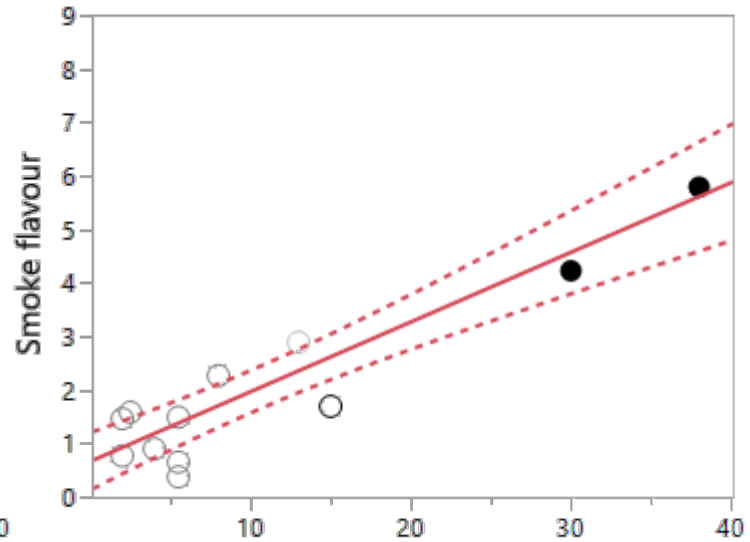
Shiraz



Wine sum of guaiacol and cresols

R^2=0.91
n=16

Chardonnay

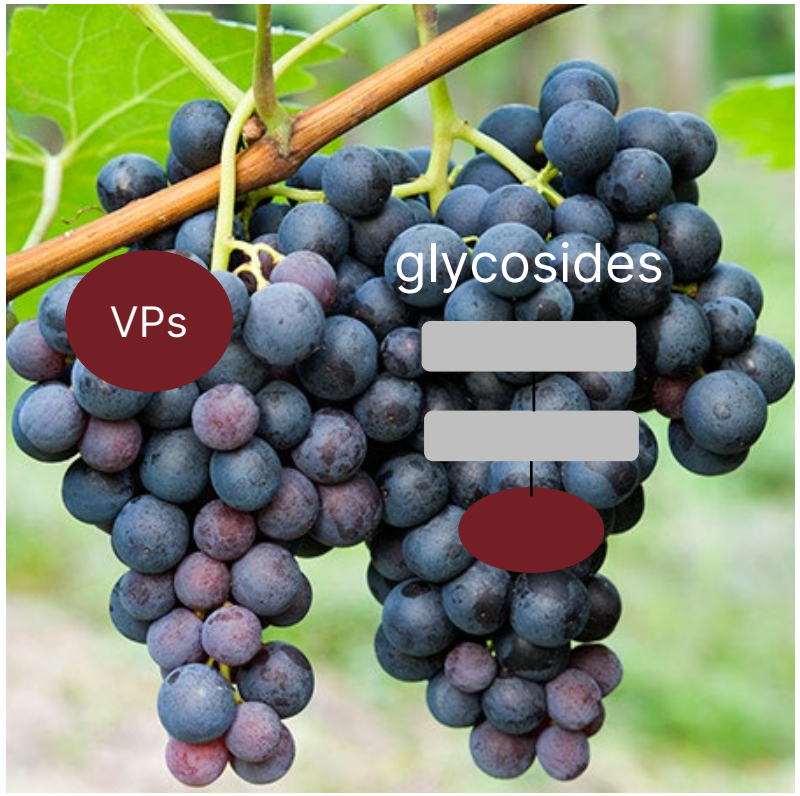


Wine sum of guaiacol and cresols

R^2=0.89
n=12

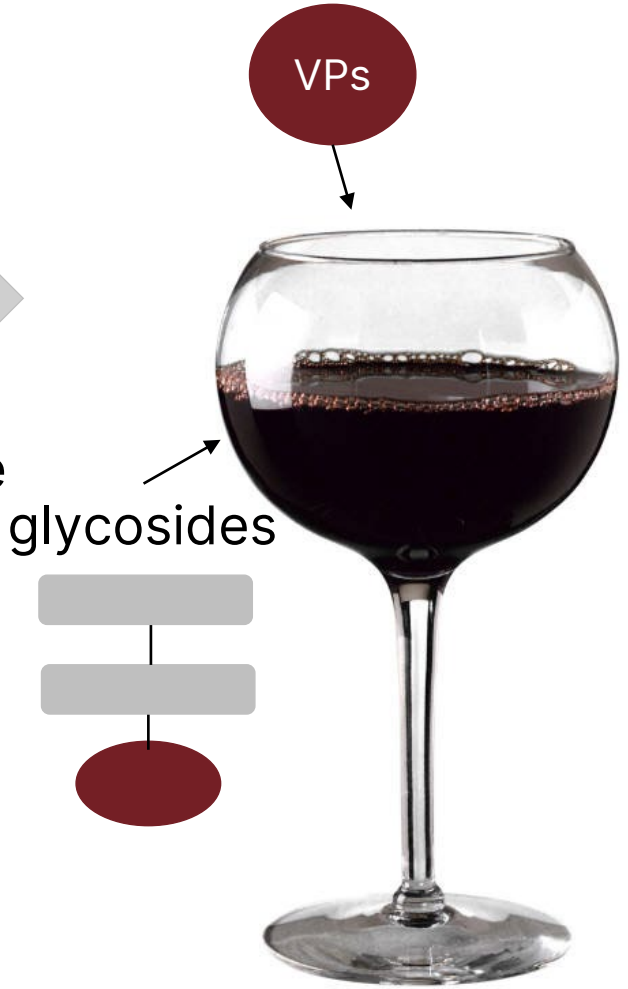
- ● Discernible smoke flavour
- ○ Not significant

Linking grape and wine composition



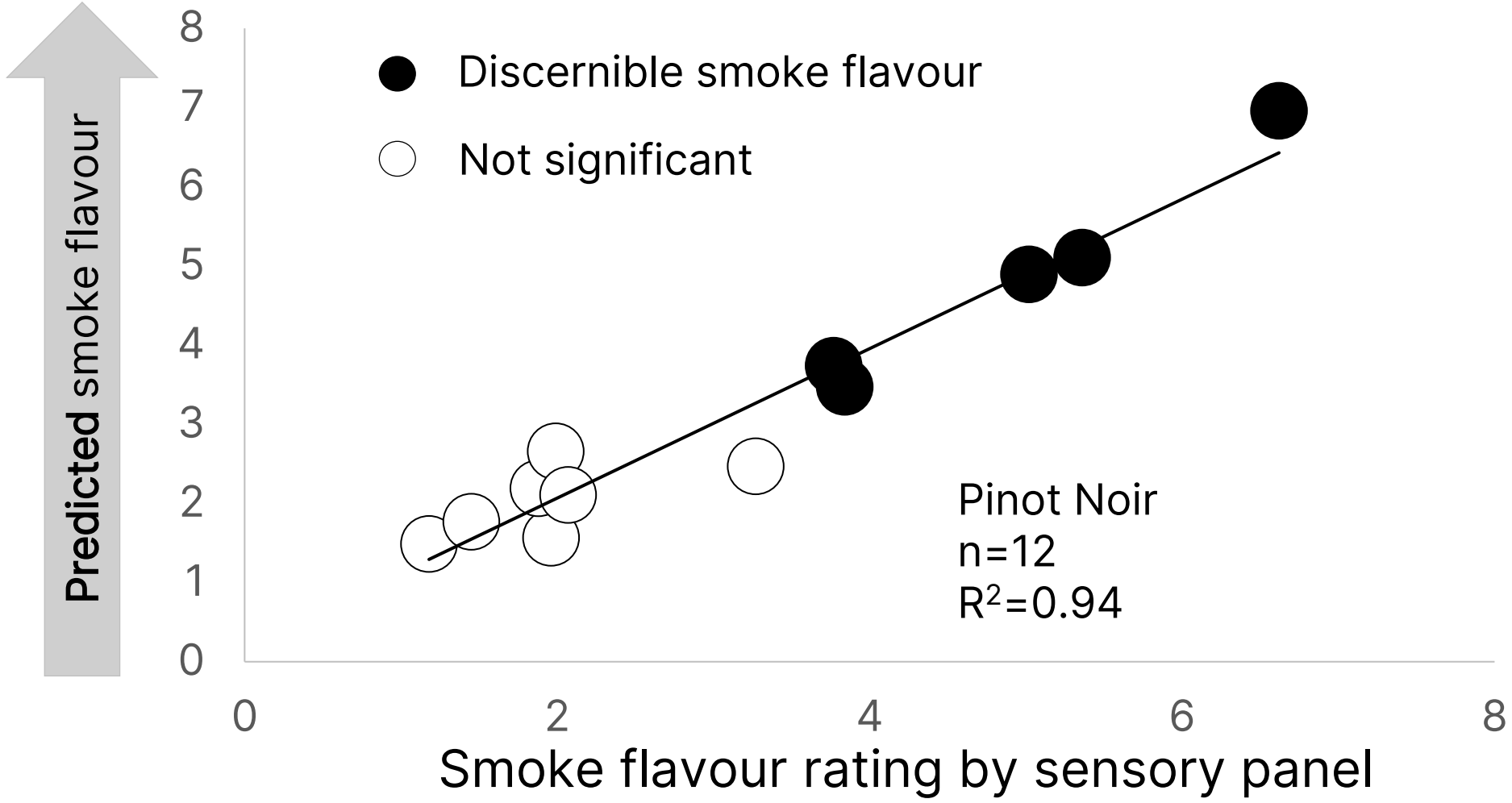
Variable proportion from grape to wine

especially Chardonnay



Predicting smoke flavour from **grape** markers

Smoke flavour predicted by a subset of Grape VPs and Glycosides



VPs

guaiacol
cresols

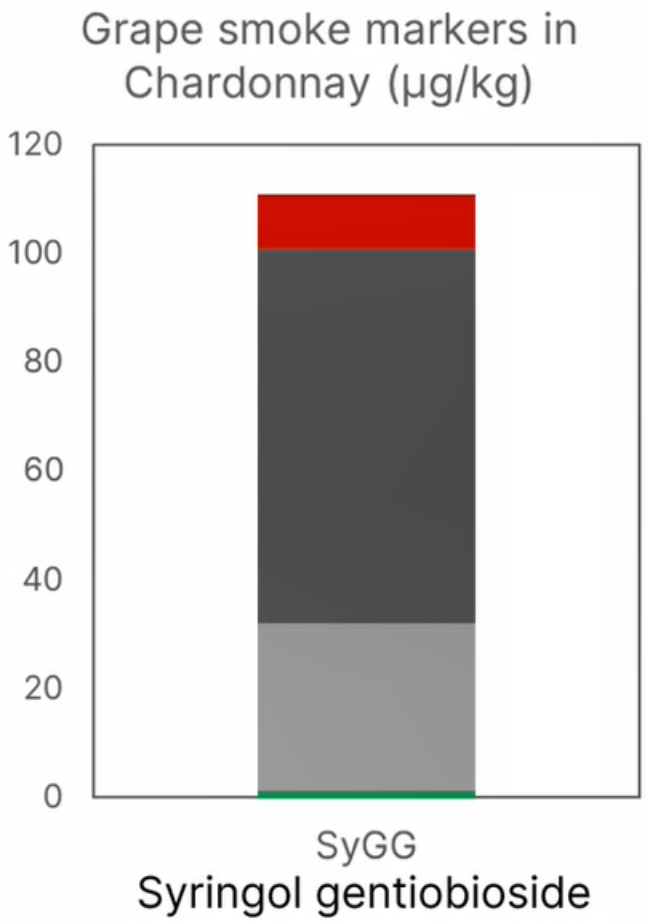
Glycosides
guaiacol rutinoside,
cresol rutinoside

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

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.

Critical concentrations in grapes

Table 5: Concentrations of volatile phenols and phenolic glycosides (μg/kg) in grapes that resulted in wines with significant smoke flavour (high risk) compared to controls, and concentrations above which only some wines were significantly smoky and some wines were not (moderate risk).

Analyte in grapes	Chardonnay		Pinot Noir		Shiraz	
	Moderate risk	High risk	Moderate risk	High risk	Moderate risk	High risk
4-Methylguaiacol	4.0	5.7	n.d.	n.d.	1.0	n.d.
Guaiacol	14.3	16.0	4.0	4.0	7.0	12.0
o-Cresol	10.3	10.3	3.0	5.0	2.0	3.0
m-Cresol	6.0	10.0	n.d.	n.d.	n.d.	n.d.
p-Cresol	2.0	7.3	n.d.	n.d.	n.d.	n.d.
4-Methylsyringol	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Syringol	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
GuRG	9.2	13.7	3.5	3.8	9.2	23.0
MGuRG	25.0	30.6	6.1	10.0	22.3	23.0
MSyGG	15.9	25.4	2.0	5.0	5.3	18.0
PhRG	5.0	7.0	4.4	10.0	1.8	16.0
CrRG	11.1	11.0	5.9	13.0	5.4	14.0
SyGG	101.2	135.7	22.2	53.0	28.6	176.0

GuRG, guaiacol rutinoside; MGuRG, methylguaiacol rutinoside; MSyGG, methylsyringol gentiobioside; PhRG, phenol rutinoside; CrRG, cresol rutinosides; SyGG, syringol gentiobioside; n.d. not determined as concentrations were below LoQ.

Critical concentrations in grapes -limitations

- Values based on **young wines** six weeks post-bottling
- Defined by '**smoke flavour**' not quality or style
- Limited by our observations
- One vintage

Summary

- Consumer and sensory linked back to grape composition
- Chardonnay, Pinot Noir and Shiraz
- Goal:
  - Balance the risk of producing smoky wine
  - While avoiding unnecessary crop losses

What's next?

- We are looking to develop a rapid screening test for grapes
- We need your help
- Please fill out the survey
  - Printout or scan code for online

WHY DO WE NEED SURVEYS?

"I'm hungry. Can you bring me a snack, please?"

"What do you feel like?"

"Oh, anything will do..."

RAW.

Unless you don't want to end up with raw broccoli, please fill in (our) surveys.

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