

Harnessing non-*Saccharomyces* yeast to combat smoke taint in red wine

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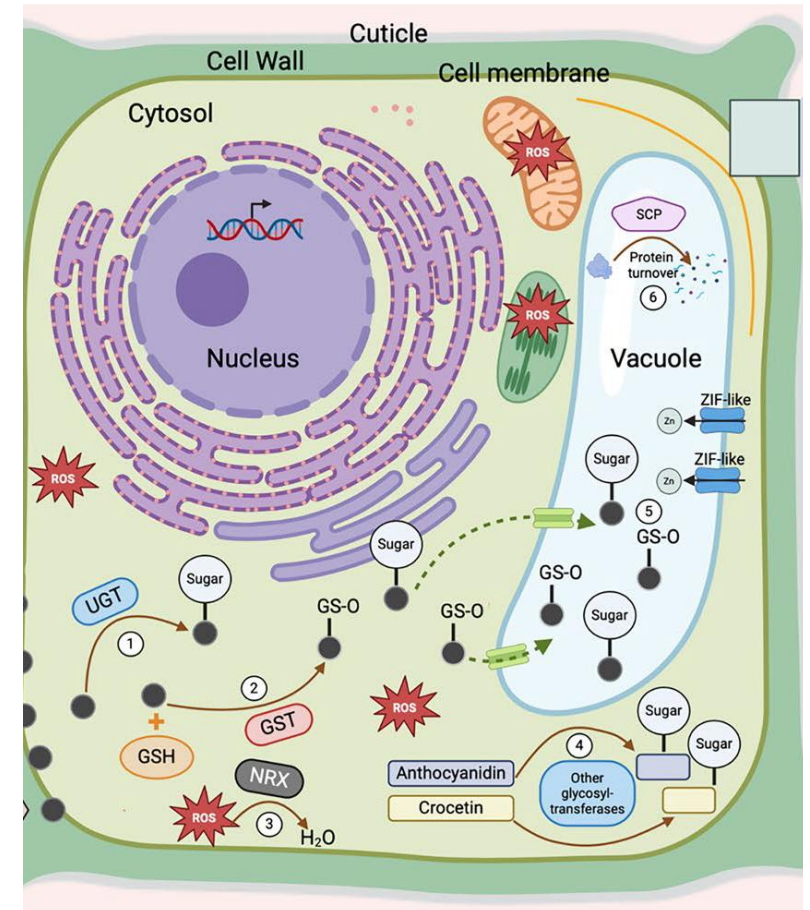
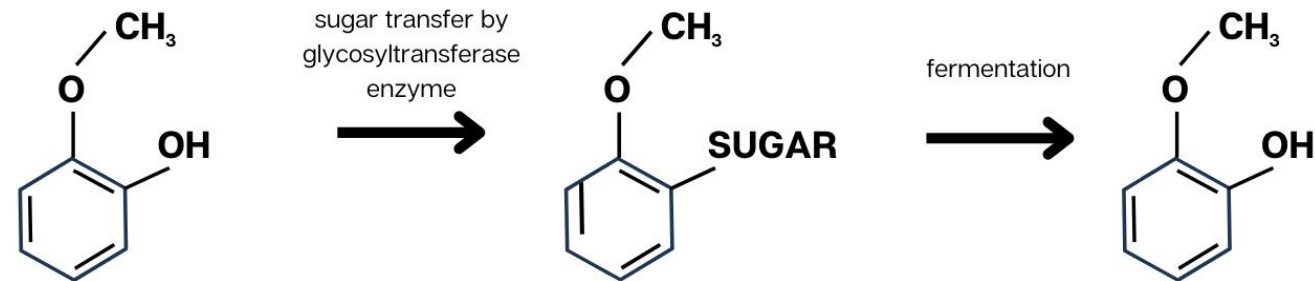


Recent examples of wildfire impact on major wine producing regions

Country/Region	Area Affected	Economic Impact	Wine Sector Implications	Source
Australia (National, 2019-2020)	60,000 ha vineyard smoke exposure	500 million AUD	50-90% harvest loss	Collins et al. (2021)
Australia (Victoria & New South Wales, 2020)	12,000 - 21,000 ha burned/damaged	140 million AUD	Rejection of grapes due to smoke taint risk	Walpole (2020)
France (Corbières, 2025)	8,500 ha burned/damaged	40 million EUR	Roughly 80% of vineyards destroyed or exposed to smoke	AP News (2025)
Spain (Catalonia & Rioja, 2022)	6,000 ha vineyard smoke exposure	15-20 million EUR	Reduced yields and loss of export potential	Rodrigues et al. (2023)
Italy (Sicily & Tuscany, 2021)	5,000 ha vineyard smoke exposure	12 million EUR	Reduced yields and economic disruption	Rodrigues et al. (2023)
South Africa (Western Cape, 2024)	52,500 ha burned (mixed land use)	Undocumented, estimated tens of millions ZAR	Vineyard and infrastructure damage, smoke exposure of grapes	Kelley et al. (2025)
United States (California, 2020)	60,700 ha vineyard smoke exposure	4.2 billion USD	Harvest cancellations, insurance claims and reduced wine production	Keeley and Syphard (2021)

Introduction

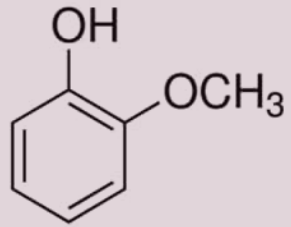
THE UPTAKE AND RELEASE OF SMOKE TAINT IN GRAPEVINES



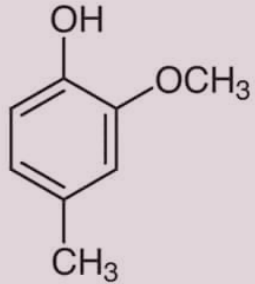
Detoxification mechanism in grapevine

● - Volatile phenol

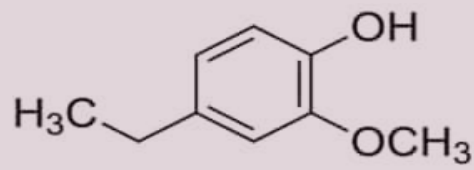
Volatile phenols selected for quantification



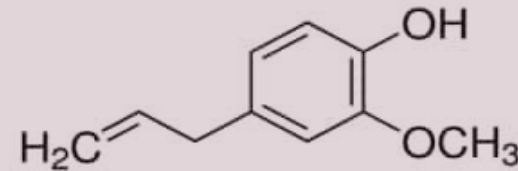
guaiacol



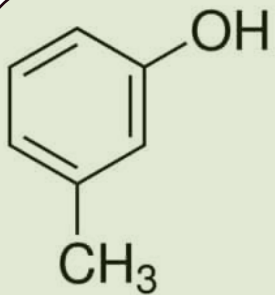
4-methylguaiacol



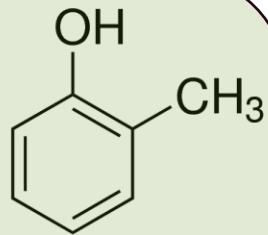
4-ethylguaiacol



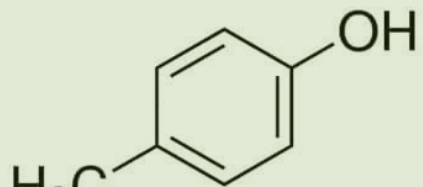
eugenol



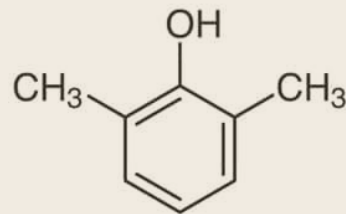
m-cresol



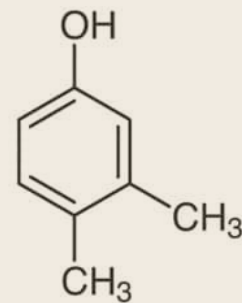
o-cresol



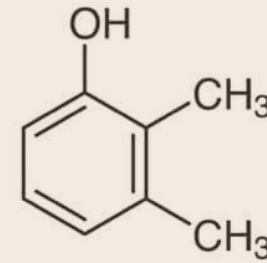
p-cresol



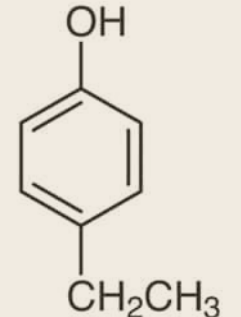
2,6-dimethylphenol



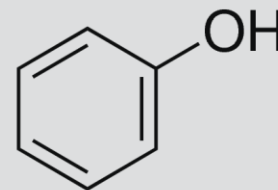
3,4-dimethylphenol



2,3-dimethylphenol



4-ethylphenol



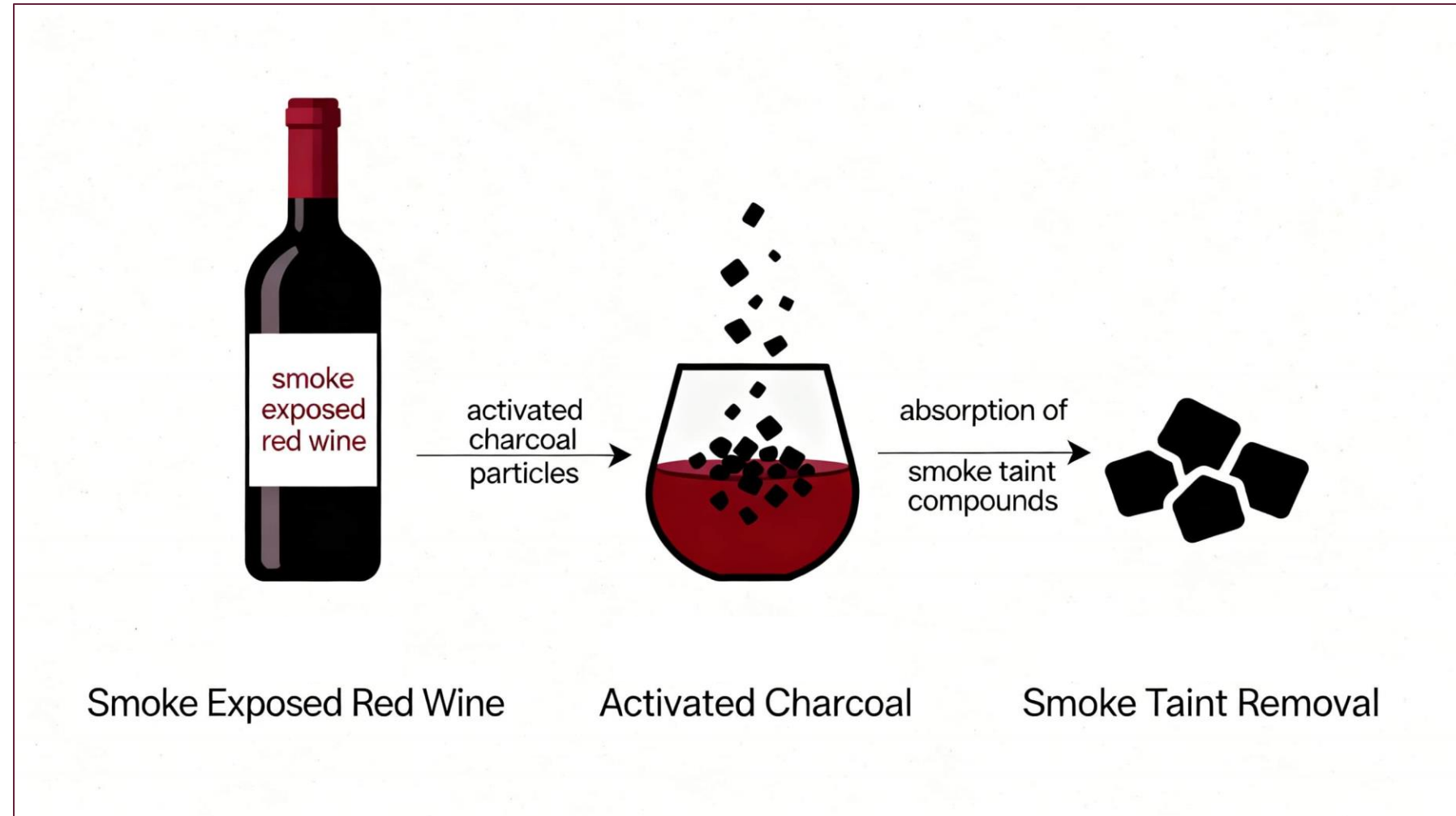
phenol

(McKay et al. 2019)

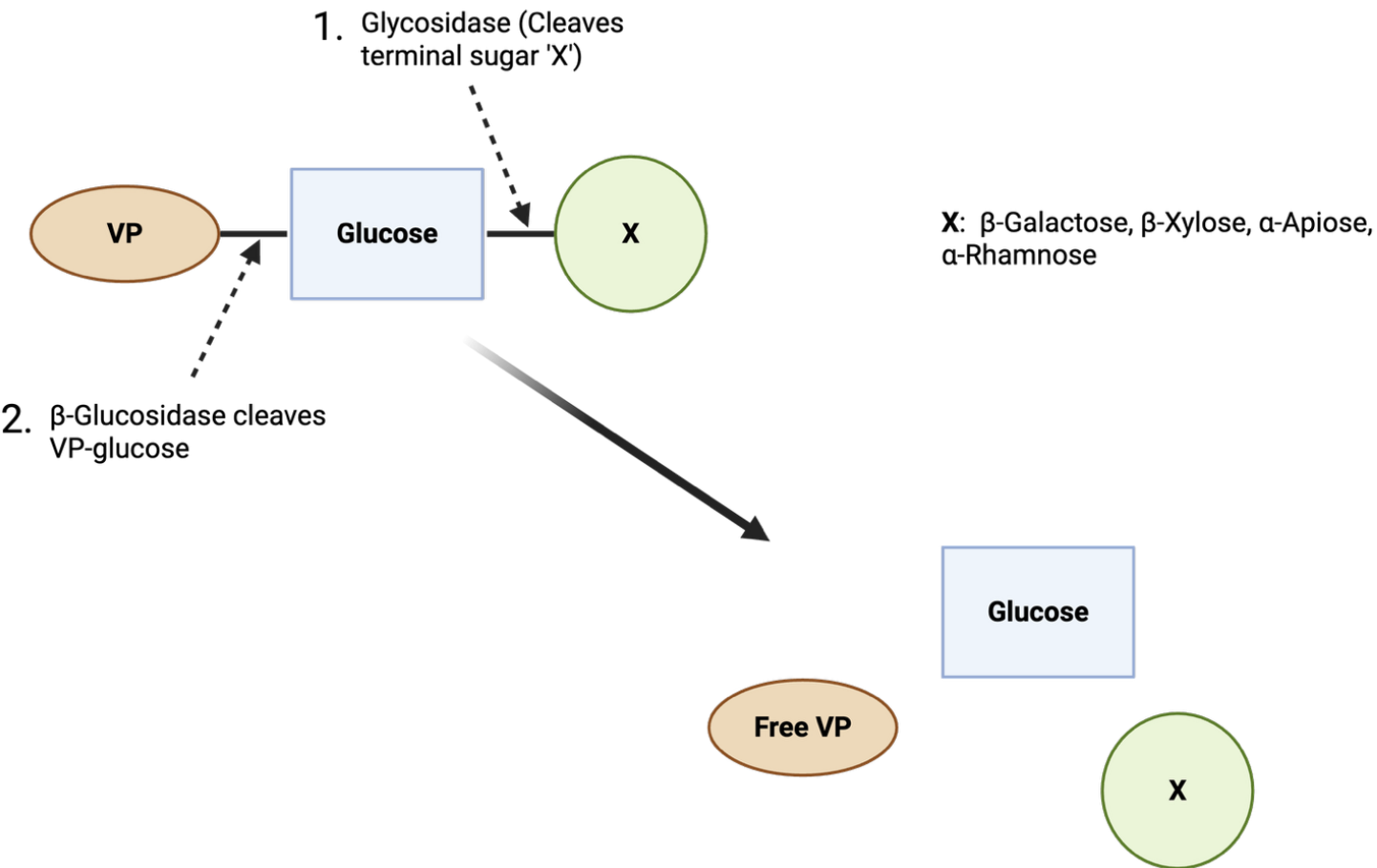
Mitigation of smoke taint

Currently, adding activated charcoal is the most widely adopted mitigation strategy.

Drawbacks → strips wine colour and aroma compounds while bound VPs not effectively removed



Yeast glycosidases



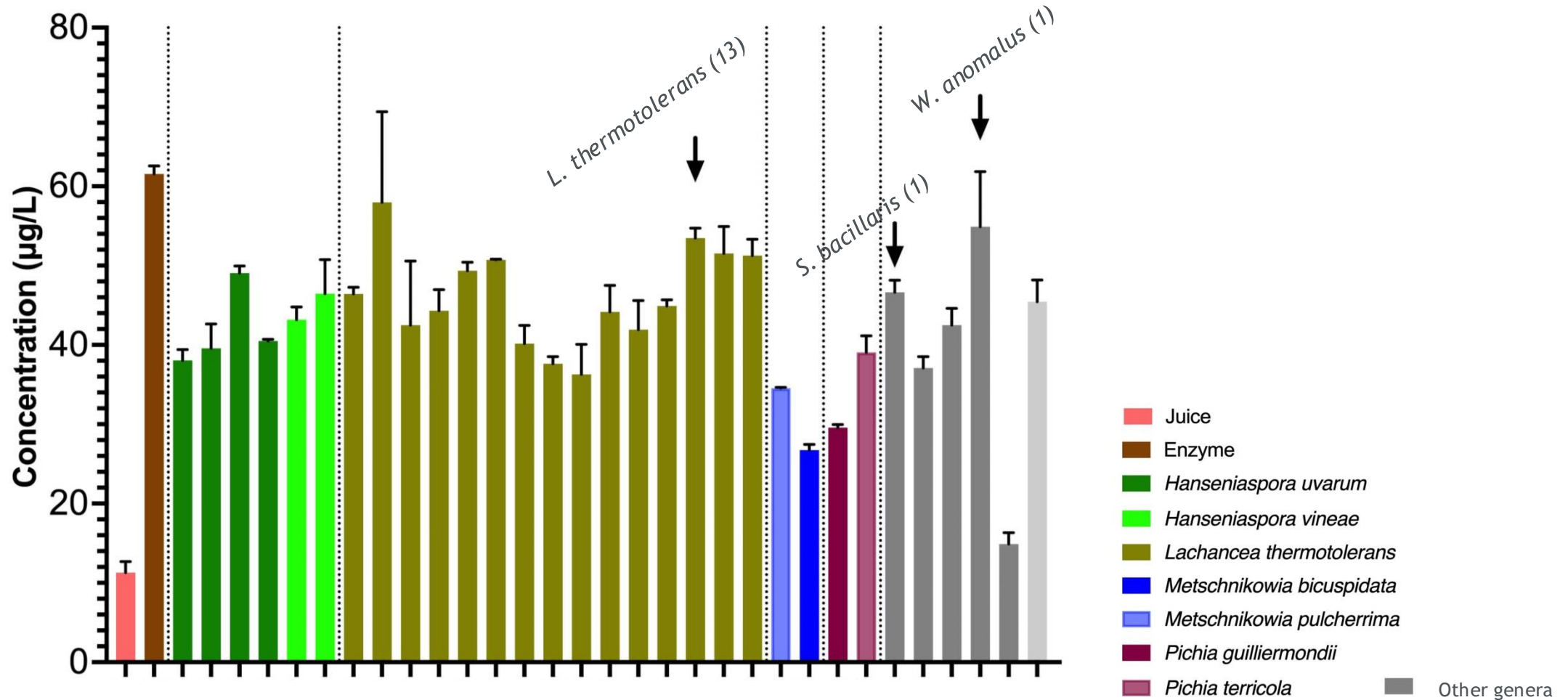
Non-*Saccharomyces* genera reported to exhibit activity: *Candida*, *Brettanomyces*, *Debaryomyces*, *Hanseniaspora*, *Lachancea*, *Metchnikowia*, *Pichia*, *Wickerhamomyces*.

S. cerevisiae wine strains previously reported to have low activity - but recent studies show they are capable of releasing VPs in smoke tainted juice (Whitmore et al. 2021, du Plessis et al. 2021).

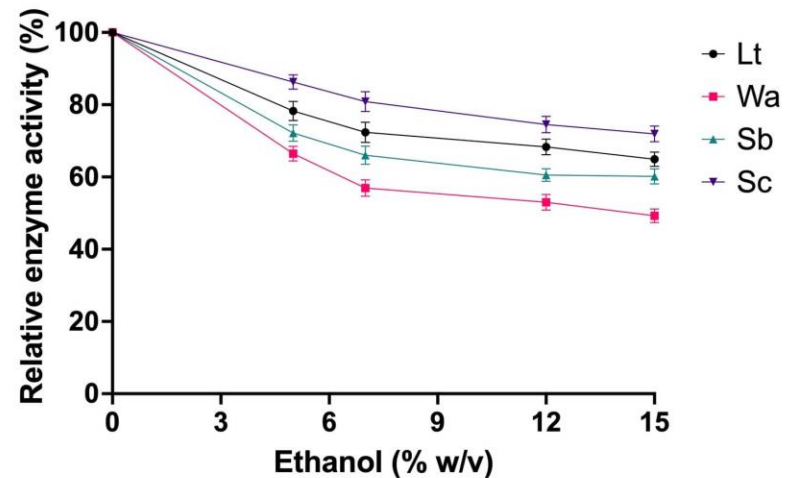
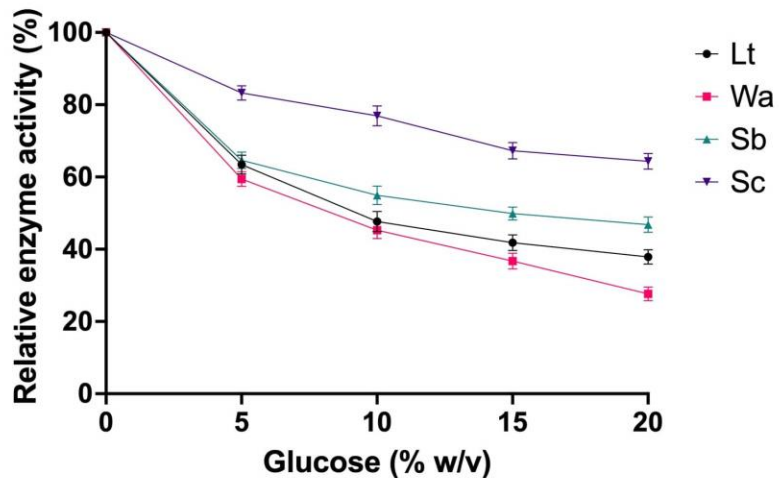
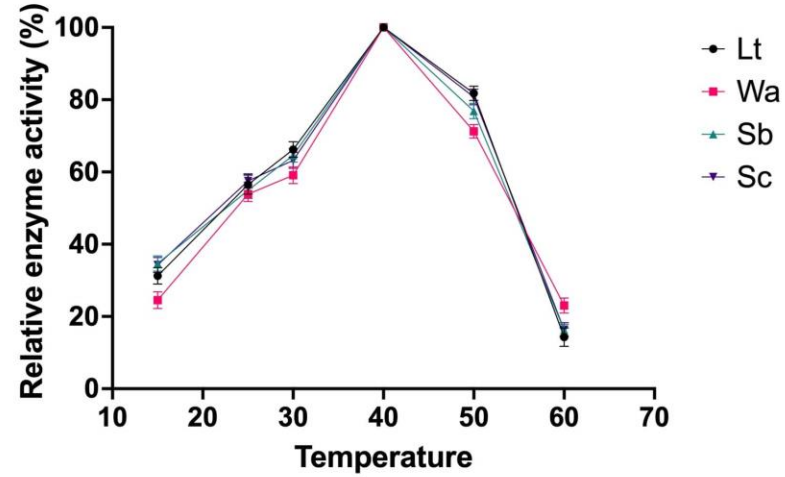
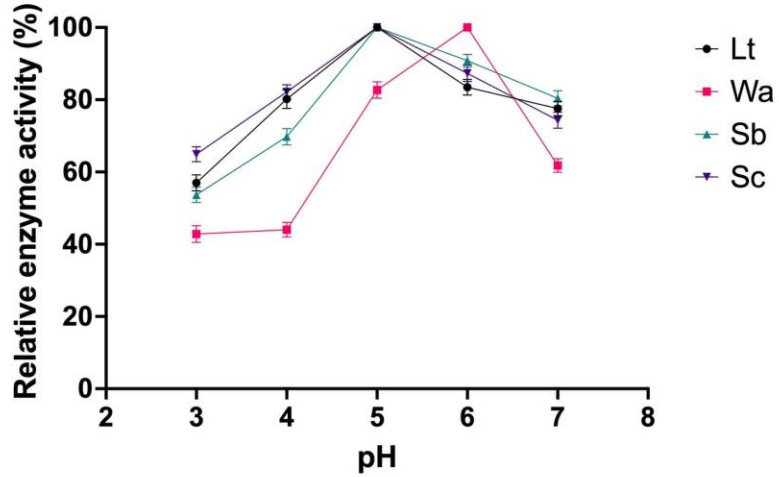
Link between terpenoids and VP release by yeast glycosidases?

Release of guaiacol varied widely between strains

Previous work:
Screening in smoked grape juice



β -glucosidase activity under wine stress



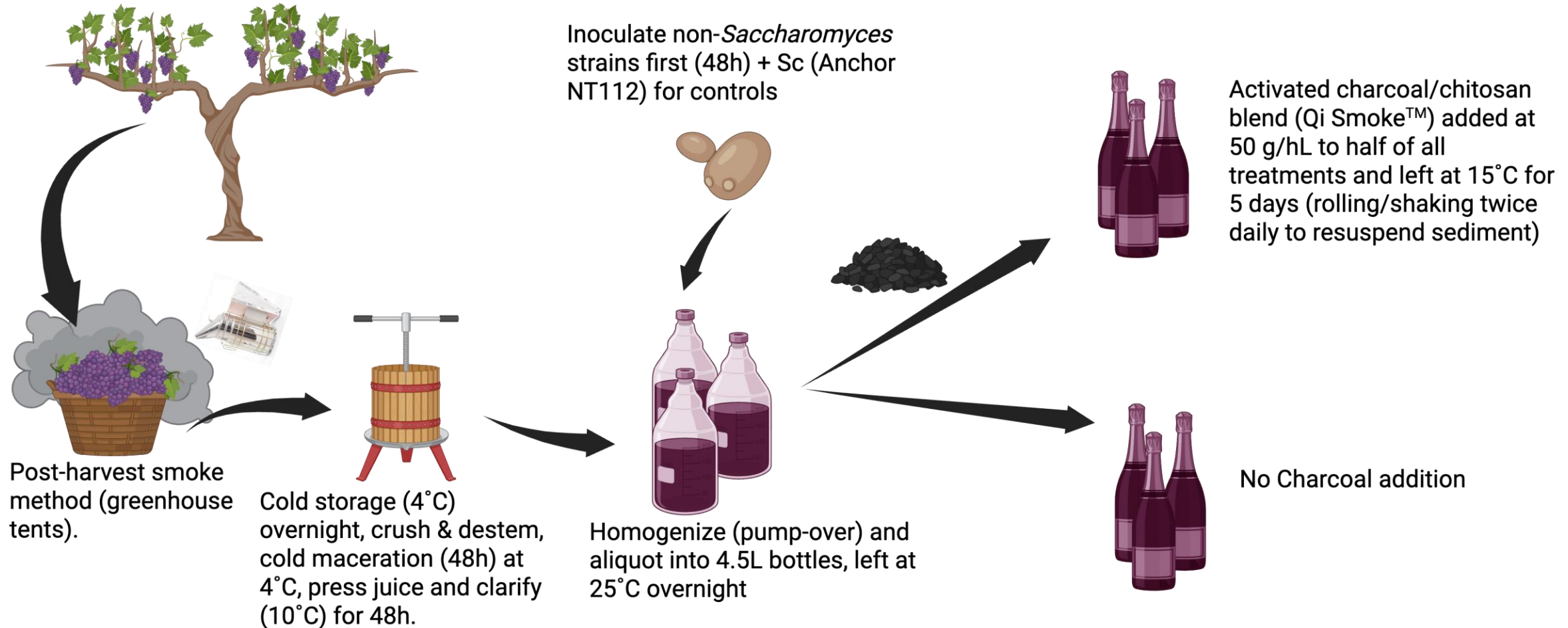
Aims of study

The aims of this study were to investigate the impact of the selected yeast strains on:

- (i) the liberation of VPs and terpenoids from smoke-exposed red grape must,
- (ii) the effect on wine colour,
- (iii) reduction of VPs after charcoal addition.

Understanding the combined effects on different glycosylated compound classes may contribute to developing yeast-based strategies for mitigating smoke taint and maintaining wine quality in the face of climate change and increased wildfire events.

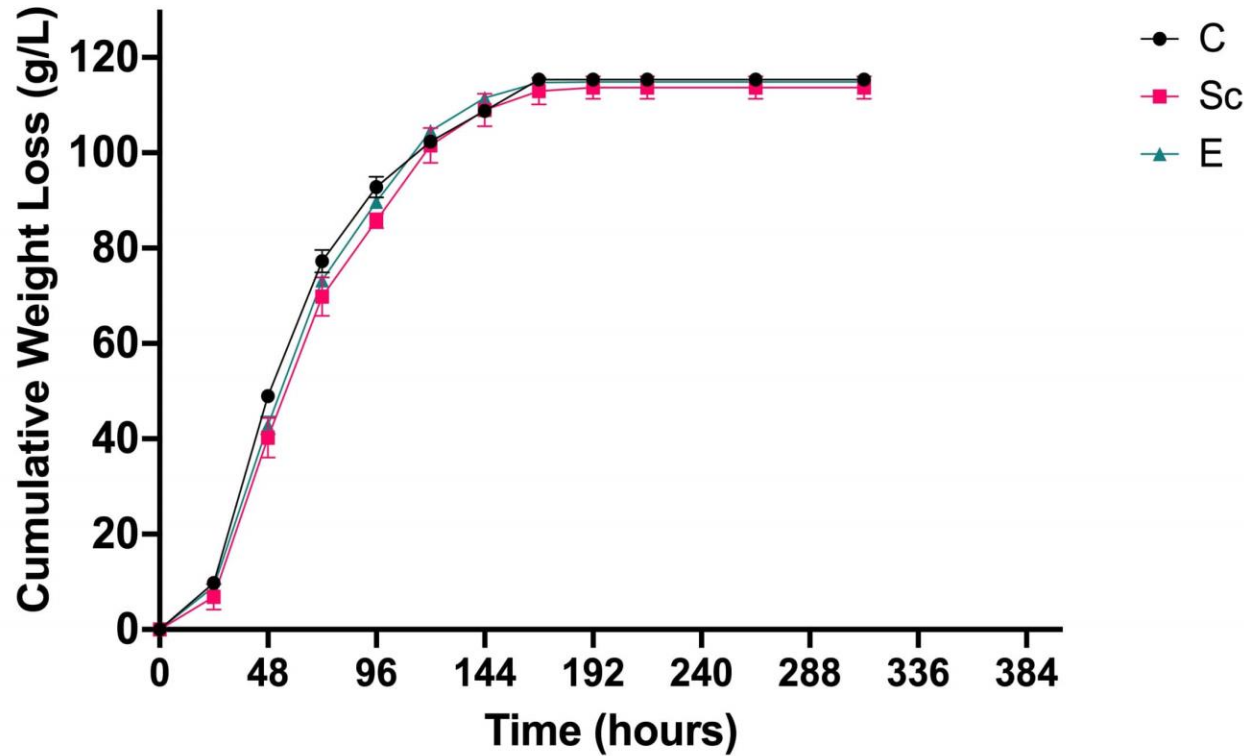
Experimental Design



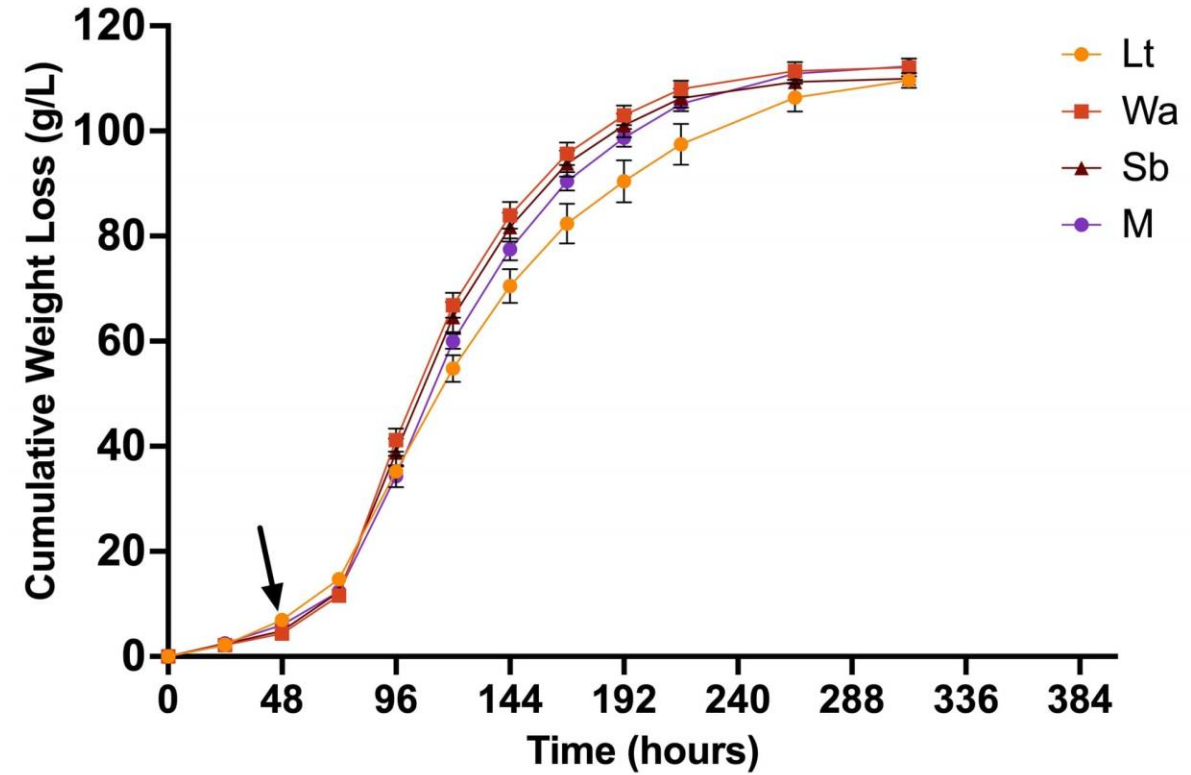
Fermentation Treatments

Strains	Code	Matrix	Replicates	Inoculum level
Lt followed by Sc	Lt	Smoked	3	3×10^6 CFU/mL
Wa followed by Sc	Wa	Smoked	3	3×10^6 CFU/mL
Sb followed by Sc	Sb	Smoked	3	3×10^6 CFU/mL
Lt + Wa + Sb followed by Sc	M	Smoked	3	1×10^6 CFU/mL for each non-Saccharomyces strain
Sc + Rapidase	E	Smoked	3	1×10^6 CFU/mL
Sc	Sc	Smoked	3	1×10^6 CFU/mL
Sc	C	Non-Smoked	3	1×10^6 CFU/mL

Fermentation kinetics

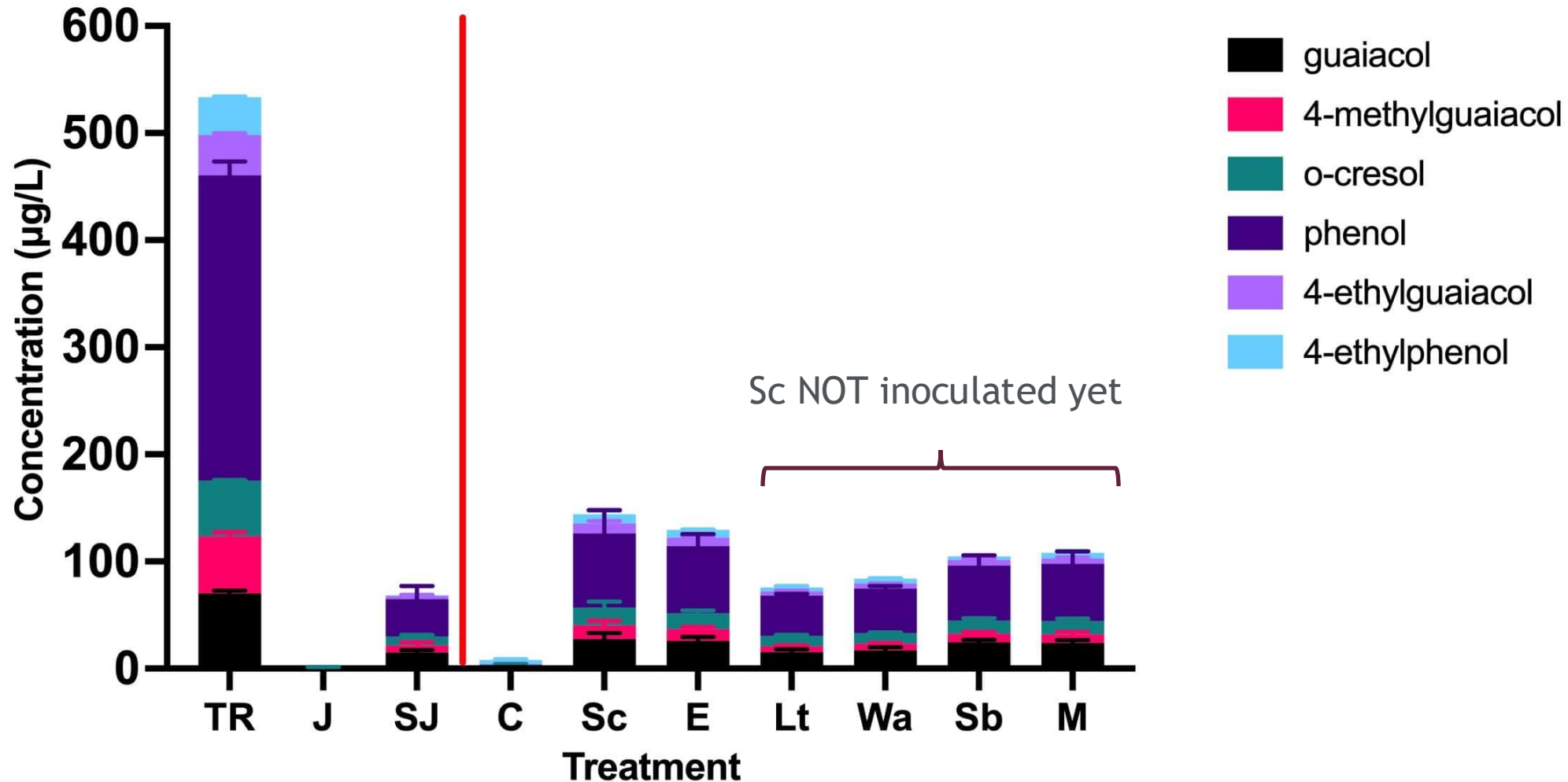


S. cerevisiae in non-smoked juice (C), smoked juice (Sc) and with commercial glycosidase (E)



S. cerevisiae sequential 48 h after *L. thermotolerans* (Lt), *W. anomalous* (Wa), *S. bacillaris* (Sb) and consortia (M)

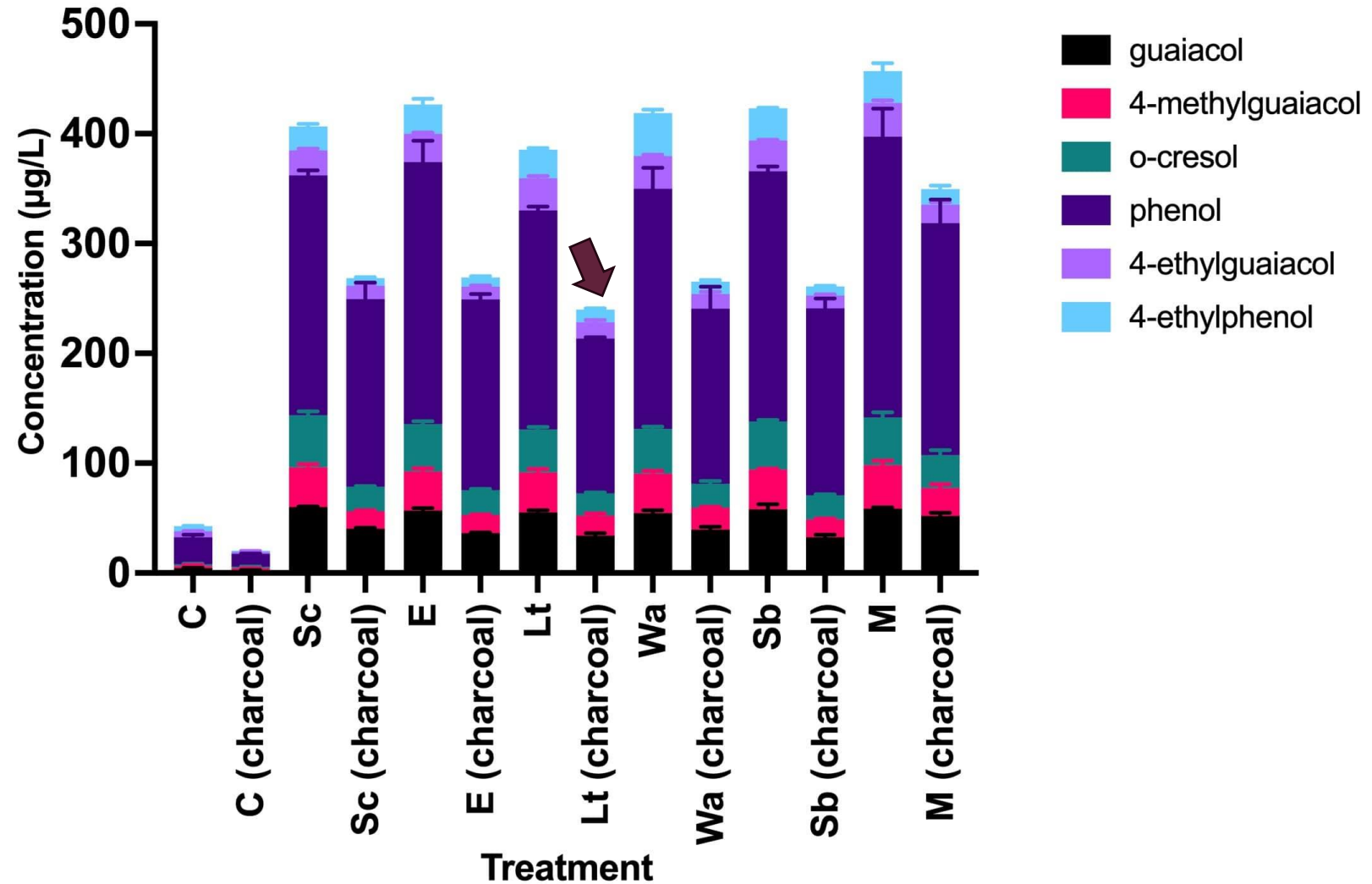
Volatile phenols after 48 h



TR: Total release
(enzyme treated
smoked juice)
J: non-smoked juice
SJ: smoked juice

Volatile phenols (Final wines)

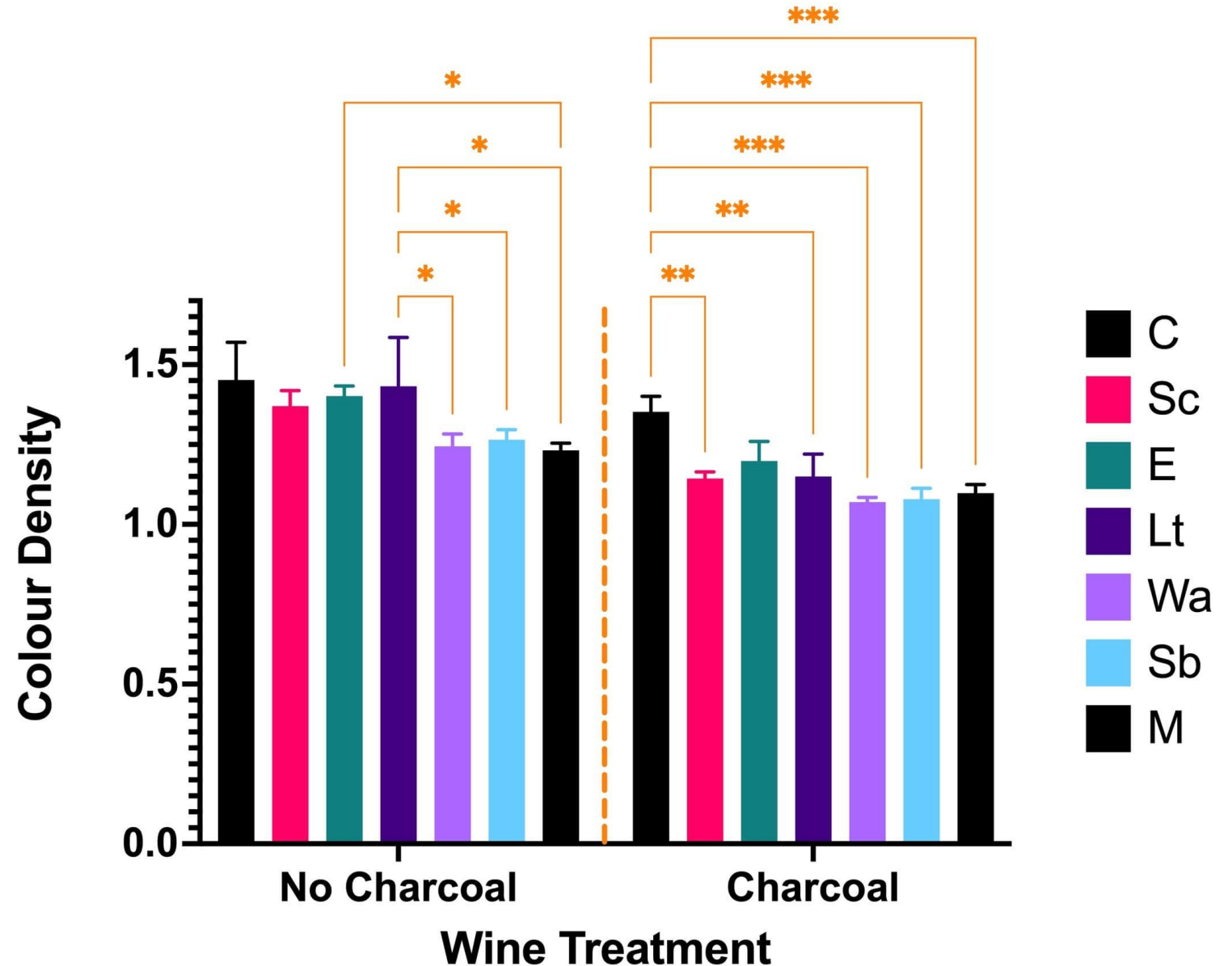
Proportional
reduction in
total VPs
relative to
initial levels



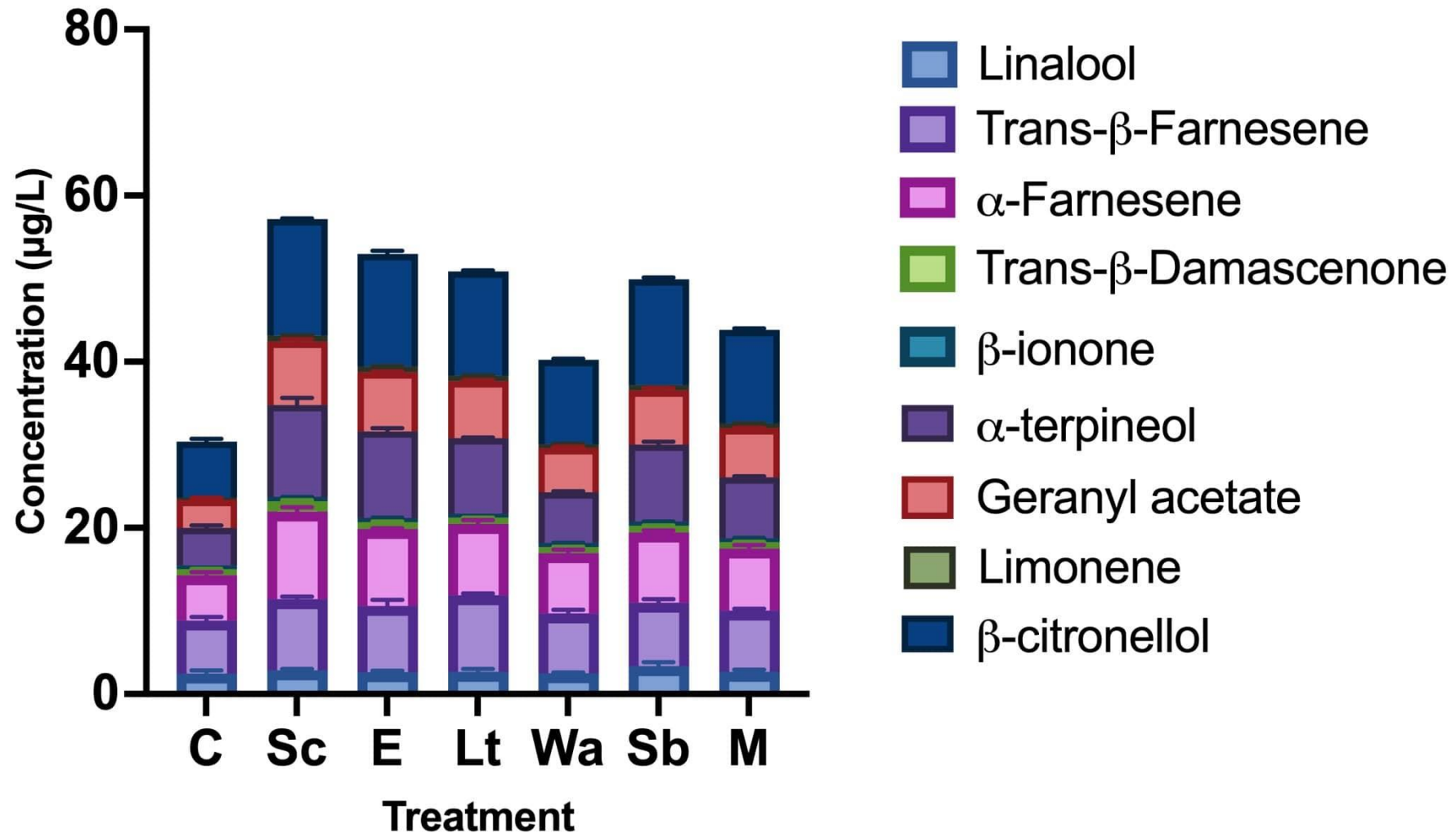
Wine Colour

Charcoal → Reduced colour density across all treatments

Yeast effects → Sb, Wa and M reduced colour density compared to Lt and Sc wines



Terpenoids

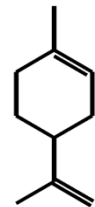
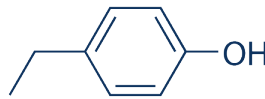
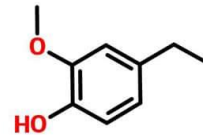


Correlation matrix of VPs and terpenoids

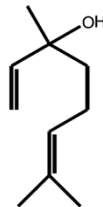
Guaiacol & o-cresol had strong positive correlation

Terpenoids strongly correlated with each other

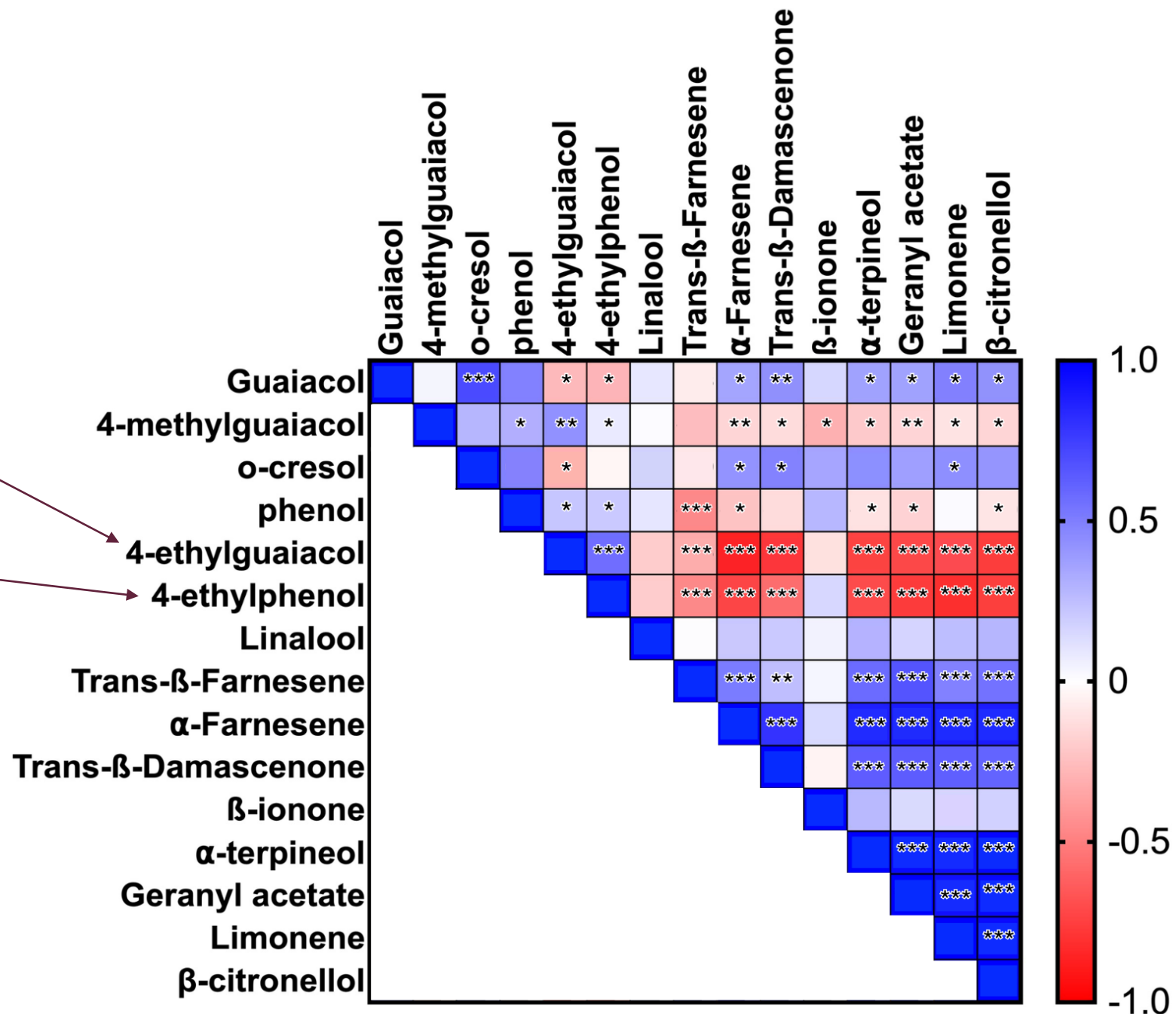
4-EG & 4-EP strong negative correlation with terpenoids



Limonene



Linalool

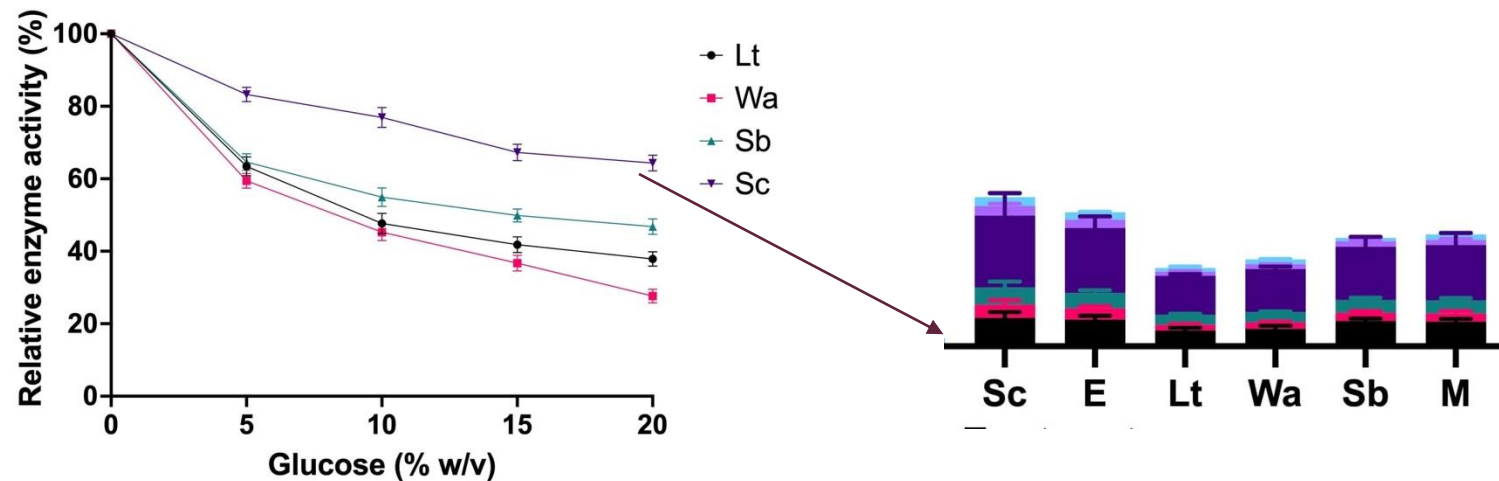


Summary

Treatment	Volatile phenols	Terpenoids	Colour Density
Sc	High	High	Stable
Lt	Low	High	Stable
Wa	Low	Low	Reduced
Sb	Moderate	High	Reduced
M	High	Moderate	Reduced

Conclusion

- Commercial *S. cerevisiae* strain selection is important within smoke taint context.
- **Glucose tolerance of *S. cerevisiae* glycosidase activity improved** compared to non-*Saccharomyces* strains
- Charcoal effectiveness not enhanced by high VP release treatments.



Acknowledgements

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