Botrytis cinerea: Coconut or Catastrophe?

Quantification of γ-Nonalactone in Botrytised and Non-Botrytised New Zealand and Australian Wines

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Introduction:

- γ-Nonalactone is an aroma compound found in wine, and is associated with coconut and stonefruit descriptors. Wines made from white grapes infected with *Botrytis cinerea* fungus ("botrytised") generally show higher concentrations of this compound.[1]
- A number of possible formation pathways (**Figure 1**) for γ-nonalactone in wine production have been hypothesised. A potential precursor of γ-nonalactone in wine is linoleic acid, which was identified previously in incubation experiments.[2]
- Separate experiments examining the metabolites of *B. cinerea* show that this fungus can produce linoleic acid,[3] demonstrating a possible link between infection of wine grapes with *B. cinerea*, and higher γ-nonalactone concentrations in botrytised wines.
- In this work, the concentration of γ-nonalactone was measured in New Zealand wines, and ferment samples with and without added linoleic acid.

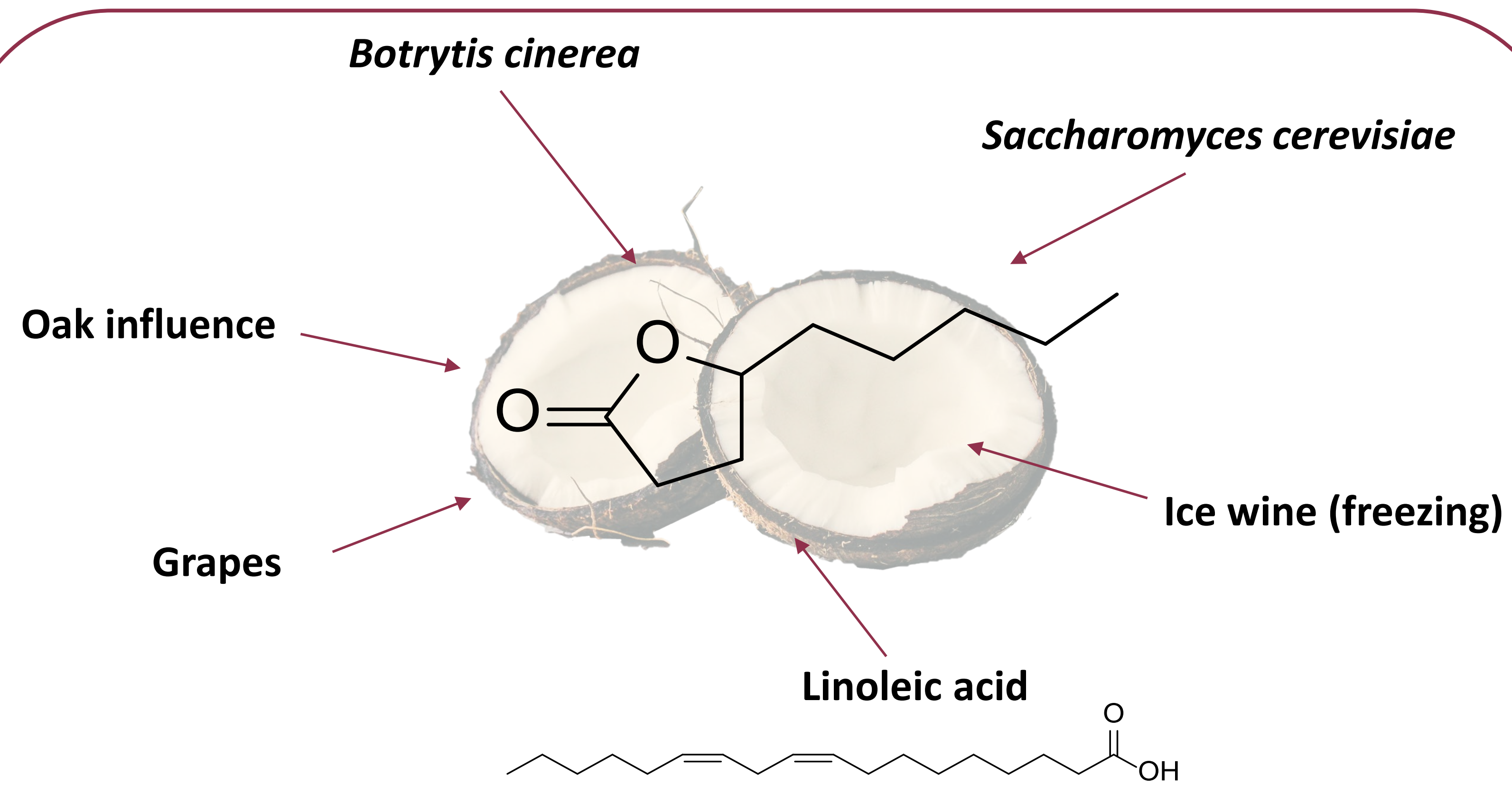
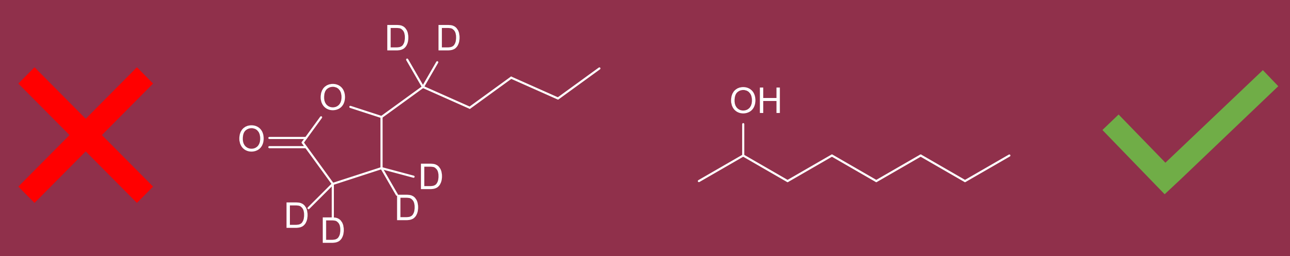


Figure 1: Possible sources of γ-nonalactone in wine[1]

Methods:

Selection of an appropriate internal standard: deuterated γ-nonalactone was synthesised,[1] but 2-octanol was instead chosen due to issues with deuterium exchange.[4]



Fermentation of synthetic grape must (SGM) with and without added linoleic acid was carried out at 28 °C, with monitoring of ferment weights. Commercial *Saccharomyces cerevisiae* EC1118 was selected for fermentations.

Analysis of samples: 50 mL ferment samples and wine samples (Table 1) were spiked with 2-octanol (100 μL of 49 μg/L solution), and prepared using solid phase extraction (SPE), then analysed using gas chromatography-mass spectrometry.

γ-Nonalactone was quantified in each sample by comparing samples to a calibration curve of known standards (spiked with 2-octanol and γ-nonalactone).

Sample	Winery, Place of Origin, Vintage	*Botrytis cinerea*
Wine A	Hunter's Sauvignon blanc, Marlborough (NZ), 2019	No
Wine B	Ata Rangi Chardonnay, Martinborough (NZ), 2018	No
Wine C	Pikes Riesling, Clare Valley (Australia), 2018	No
Wine D	Pegasus Bay Noble Barrique Sauvignon blanc, Waipara Valley (NZ), 2014	Yes
Wine E	Blank Canvas Meta Riesling, Marlborough (NZ), 2018	Yes
Wine F	Ata Rangi Kahu Botrytis Riesling, Martinborough (NZ), 2016	Yes

Table 1: Wines analysed in this study

Results and Discussion:

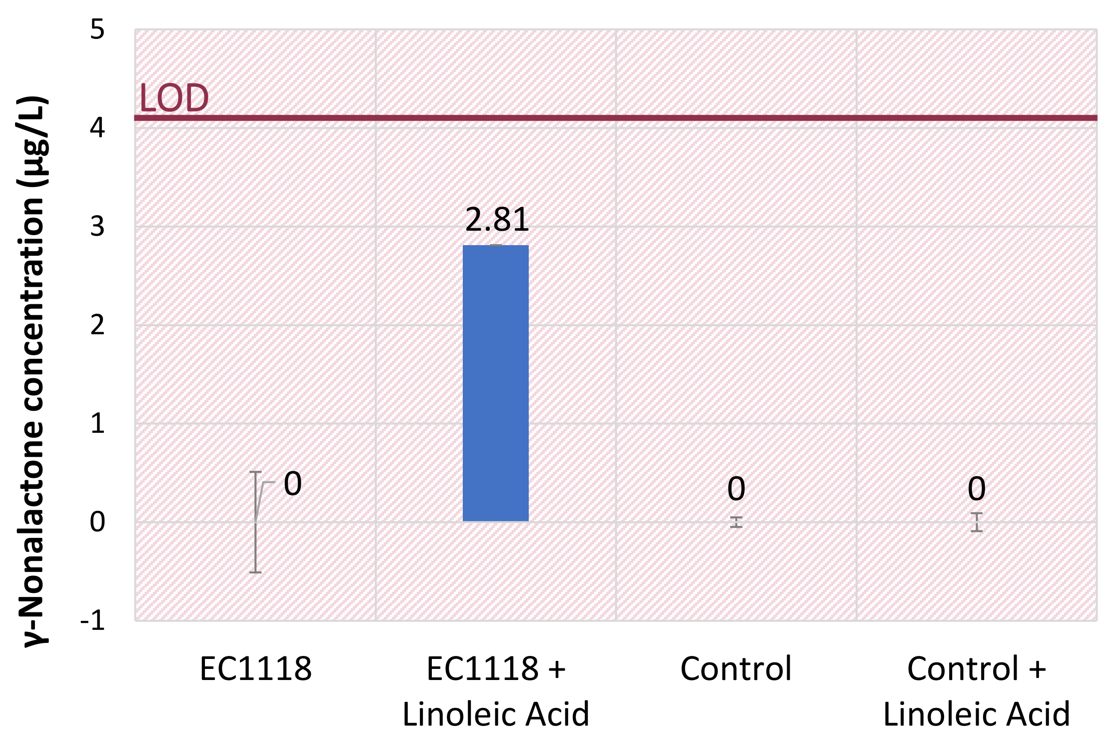


Figure 2: Measured concentration of γ-nonalactone (μg/L) in ferment samples compared to the LOD (4.12 μg/L)

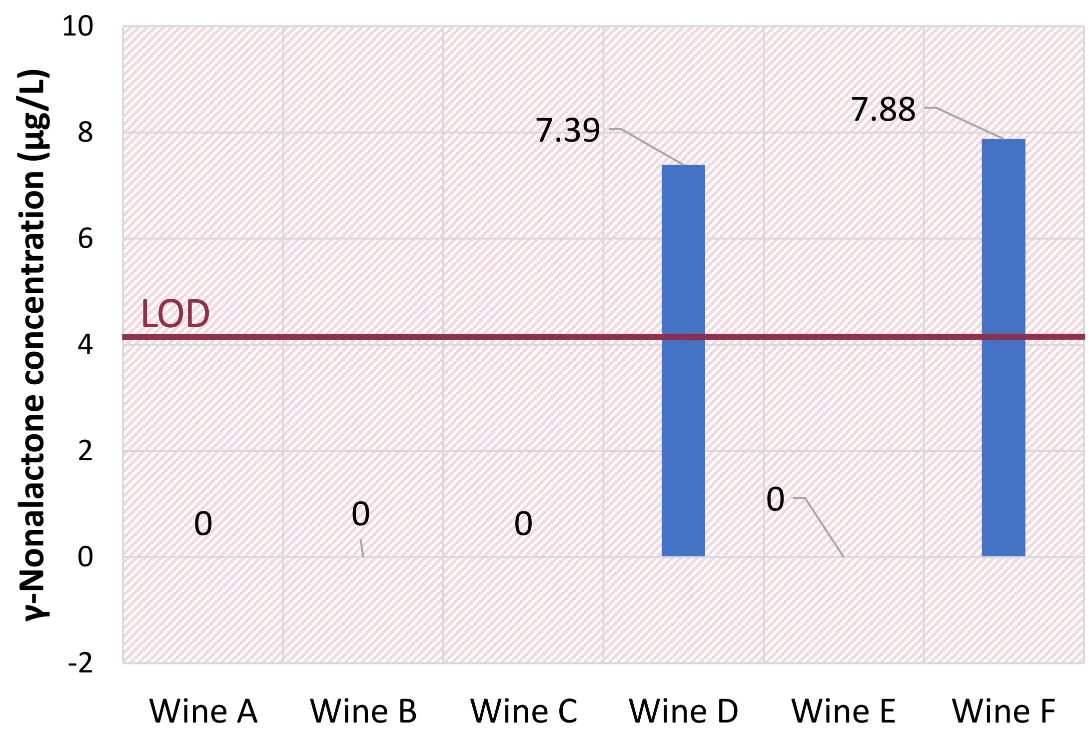


Figure 3: Measured concentration of γ-nonalactone (μg/L) in wine samples compared to the LOD (4.12 μg/L)

- Although all ferment samples analysed (Figure 2) had γ-nonalactone concentrations below the limit of detection (LOD), there may be a greater concentration of γ-nonalactone in the sample with added linoleic acid. Figure 3 shows that, interestingly, wines D and F had concentrations of γ-nonalactone above the limit of detection (7.39 and 7.88 μg/L. respectively).
- Both wines D and F (Table 1) had *B. cinerea* influence, suggesting a possible link between the presence of noble rot and higher concentrations of γ-nonalactone in the finished wine. Wine F was produced via tank fermentation, so oak influence is not considered a contributing factor to the concentration of γ-nonalactone in this wine.
- Wines A, B and C did not show γ-nonalactone present, and also did not have any *B. cinerea* influence (Table 1).

Future Work:

- Development and synthesis of a more appropriate internal standard enabling more sensitive quantification of γ-nonalactone in wine.
- Further fermentation experiments to elucidate the link between *B. cinerea* and γ-nonalactone concentration in wine.
- Survey of New Zealand wines to identify wines in which γ-nonalactone is prevalent.
- Investigation of other potential factors influencing γ-nonalactone concentration in wine (Figure 1).

References

(1) Cooke, R. C.; Capone, D. L.; van Leeuwen, K. A.; Elsey, G. M.; Sefton, M. A. Quantification of Several 4-Alkyl Substituted γ-Lactones in Australian Wines. *J. Agric. Food Chem.* **2009**, *57* (2), 348–352. https://doi.org/10.1021/jf8026974.

(2) Garbe, L.-A.; Lange, H.; Tressl, R. Biosynthesis of γ-Nonalactone in Yeast. In *Aroma Active Compounds in Foods*; ACS Symposium Series; American Chemical Society, 2001; Vol. 794, pp 176–182. https://doi.org/10.1021/bk-2001-0794.ch014.

(3) Cooper, L. L. D.; Oliver, J. E.; De Vilbiss, E. D.; Doss, R. P. Lipid Composition of the Extracellular Matrix of Botrytis Cinerea Germlings. *Phytochemistry* **2000**, *53* (2), 293–298. https://doi.org/10.1016/S0031-9422(99)00495-1.

(4) Ferreira, V.; López, R.; Cacho, J. F. Quantitative Determination of the Odorants of Young Red Wines from Different Grape Varieties. *J. Sci. Food Agric.* **2000**, *80* (11), 1659–1667. https://doi.org/10.1002/1097-0010(20000901)80:11<1659::AID-JSFA693>3.0.CO;2-6.