Use of locally-isolated *Saccharomyces uvarum* strain, CN1, to mitigate the negative effects of *Botrytis* and sour rot in white wine

Daniel Phillipow[1,2], Jennifer Kelly[1,2] and Debra Inglis[1,2]

[1]Department of Biological Sciences, Faculty of Math and Science – Brock University

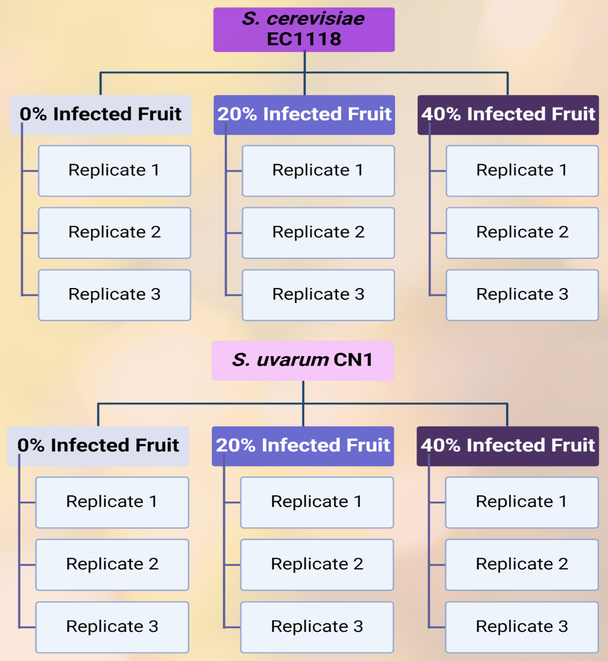
[2]Cool Climate Oenology and Viticulture Institute – Brock University

Background

- Sour rot is a widespread disease affecting both red and white grape varieties globally (Hall et al., 2018). It annually causes significant revenue loss due to decreased grape quality and resultant wine (Hall et al., 2018).
- The disease begins with damaged berries fermenting by naturally occurring yeast, leading to the production of ethanol and subsequent oxidation to acetic acid by acetic acid bacteria (Barata et al. 2012).
- Affected berries exhibit browning, softening, and leaking of fermented pulp, attracting *Drosophila* flies, and potentially secondary invasions from fungal pathogens like *Botrytis cinerea* (Hall et al., 2018).
- Infected fruit typically shows higher levels of **negative** aromatic compounds such as **acetic acid** leading to potential rejection of fruit by wineries (McFadden-Smith, 2010).

- ***Saccharomyces uvarum* (CN1)** yeast isolate exhibits potential to mitigate the effects of sour rot and *Botrytis* taint on grape must quality through the **consumption of acetic acid** present in rot-infected fruit during fermentation (Kelly et al., 2020).
- Past studies show CN1 produces lower levels of acetic acid and ethyl acetate and **higher levels of volatile aroma compounds (VOCs)** adding to the fruity aromas of the wine (Kelly et al., 2020).
- This yeast may have implications in the industry as a use for wineries to produce quality wines from fruit that would otherwise be rejected and discarded.

Methods



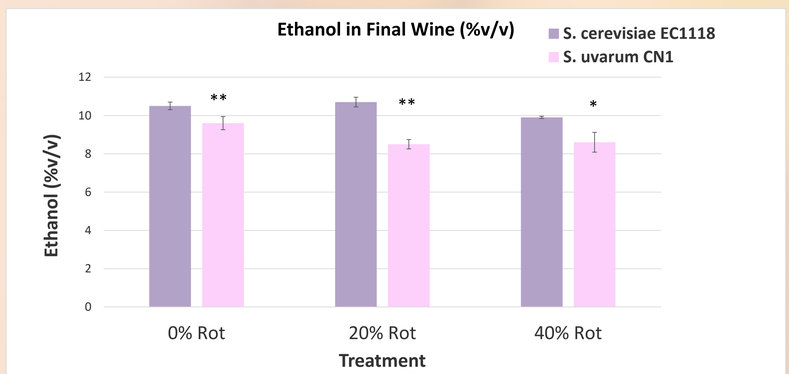
- Fermentation treatments were conducted in triplicate utilizing commercial strain, *S. cerevisiae* EC1118 and locally isolated *S. uvarum* CN1 strain.
- Grapes were visually examined for signs of rot, defined as the presence of > 50% rot within a cluster and separated from clean fruit.
- Following assessment, grapes underwent pressing, and the resultant juices, whether clean or affected by rot, were blended by volume.
- Each fermentation was 22L, controlled at a temperature of 17°C, and inoculated with yeast at a concentration of $2x10^6$ cells/mL.
- Fermentations were monitored daily until completion.

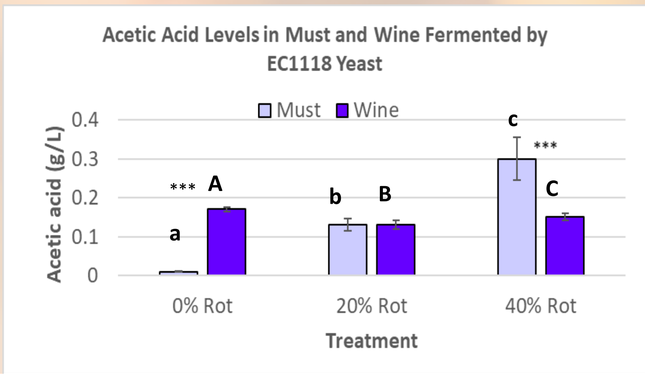
Objectives

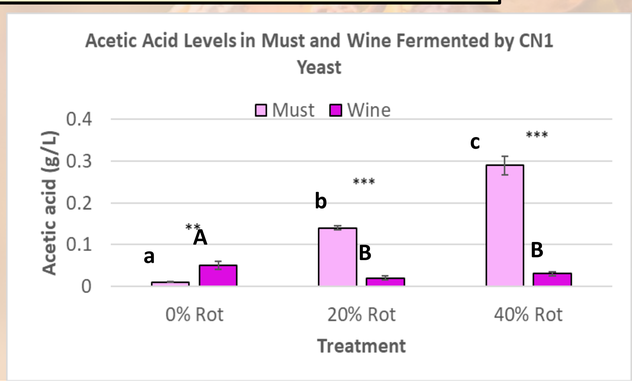
To assess the application of locally isolated *Saccharomyces uvarum* CN1 to **mitigate the impact of *Botrytis* and sour rot** taints in white grape varieties through **consumption of acetic acid**. We will also assess the ability of *S. uvarum* strains to form volatile fatty acids, higher alcohols, and esters that **increase beneficial volatile aroma compounds (VOCs)** in wine.

Results

Note: Fermentations progressed at similar rates between both yeast strains for all treatments (control, 20% rot, and 40% rot).

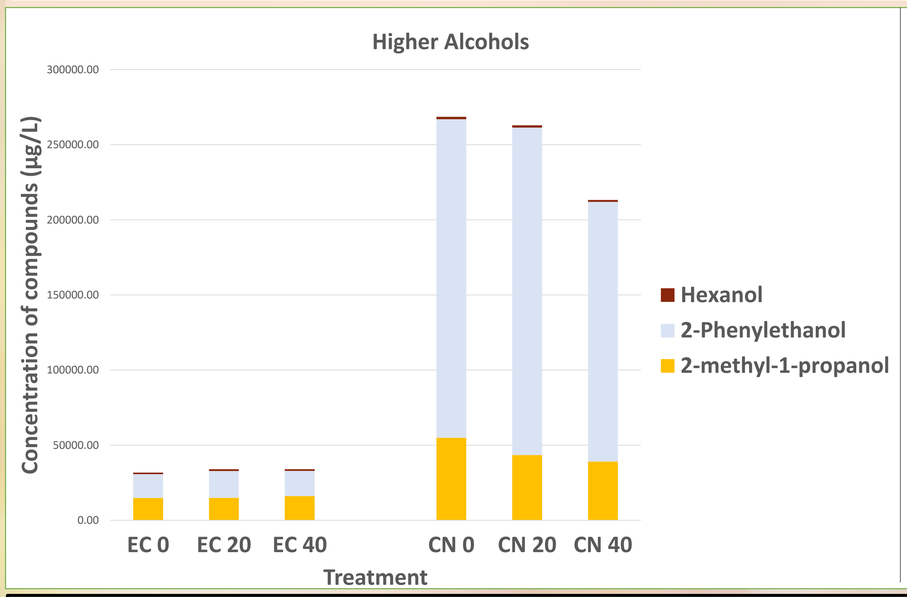


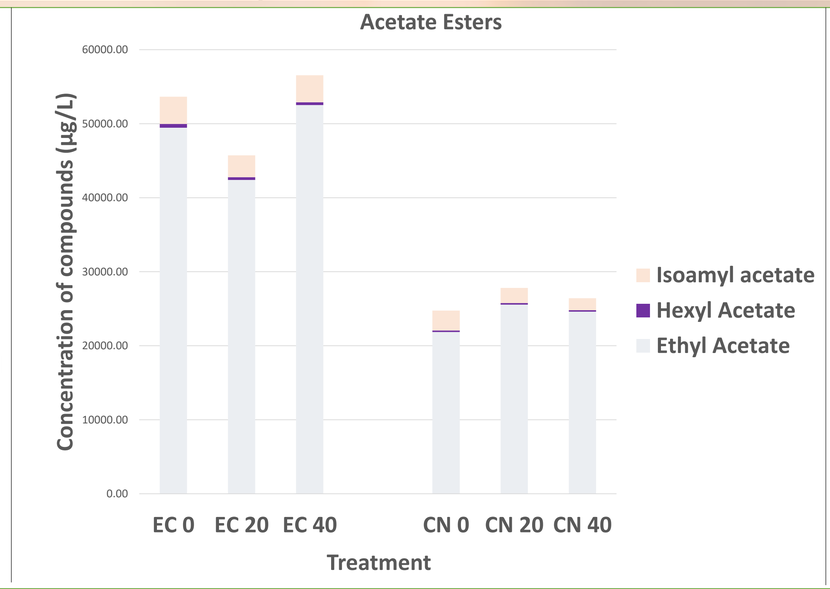


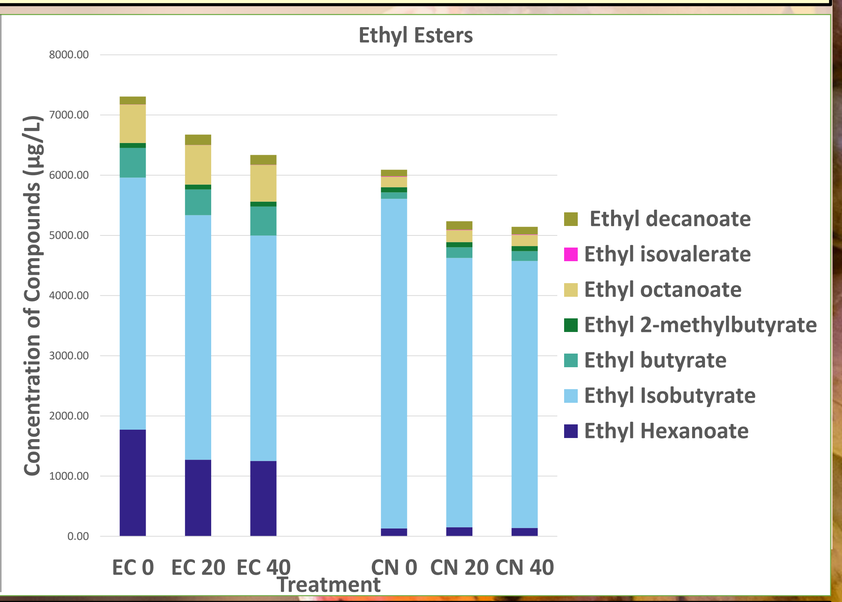


Interpretation:
Treatments fermented with *S. uvarum* CN1 produced wines with significantly less alcohol (8.5-9.6%) when compared to *S. cerevisiae* EC1118 (9.9-10.7%).
Note: Significant differences were determined through Student's *t*-tests. *(α <0.05), **(α <0.01), and *** (α <0.001) show significant difference between yeast within the same rot treatments.

Interpretation:
Fermentations carried out using *S. uvarum* CN1 yeast performed significantly greater at reducing acetic acid levels present in rot-affected must and produced lower levels of acetic acid in clean must.
Note: Significant difference between treatments of must (represented with lowercase letters) and wine (represented with uppercase letters) was determined through a post-hoc test where bars with different letters represent significant difference (α<0.05). *(α <0.05), **(α <0.01), and *** (α <0.001) also show significant difference between must and wine within a treatment.







Interpretation: Wines fermented using *S. uvarum* CN1 produced significantly higher levels of VOCs including 2-methyl 1-propanol (Green), Hexanol (Herbaceous), 2-Phenylethanol (Honey/rose), Ethyl Isobutyrate (Sweet fruits), Ethyl Isovalerate (Apple), and Ethyl 2-methylbutyrate (Fruity). Rot level had little impact on VOC distribution for each yeast strain.

Conclusions

- *Saccharomyces uvarum* CN1 demonstrates an ability to **reduce acetic acid**, an undesirable compound in wines, significantly more than the commercial *Saccharomyces cerevisiae* EC1118 from rot-affected must. CN1 also demonstrates an ability to **produce significantly less acetic acid** in clean fruit. Compared to EC1118, CN1 demonstrated a 13-fold reduction in the 0% rot treatment, a 6-fold reduction in the 20% rot treatment, and a 5-fold reduction in the 40% rot treatment.
- In comparison to wines fermented with EC1118, CN1 produced **higher amounts of multiple higher alcohols and ethyl esters**. This is important for Riesling wines because these compounds contribute to aromatic complexity, enhancing fruity, floral, and herbaceous notes, which are key sensory attributes of high-quality Rieslings
- This ability may be used as a **remediation tool** for wineries as a new technique to produce quality white wines and to prevent the unnecessary loss of wine grapes. This tool is of increasing importance with the uncertainty of temperature and precipitation changes due to climate change.
- Beyond its potential as a remediation tool for rot-affected musts, CN1's significantly lower ethanol production offers a novel strategy for naturally producing **lower-alcohol wines**. This characteristic could be particularly valuable for winemakers seeking to craft wines with balanced alcohol levels while maintaining aromatic intensity.

Future Directions:

- Sensory analyses are currently being carried out to test whether CN1 positively and significantly benefited the overall profile of the wines.
- Additional trials using other strains of locally isolated *S. uvarum* yeast should be trialed in white wine fermentations to further explore the capability of mitigating the deleterious sensory affects brought on by sour rot and *Botrytis* and the different profiles these yeast may offer.

References: Barata, A., Santos, S. C., Malfeito-Ferreira, M., & Loureiro, V. (2012). New insights into the ecological interaction between grape berry microorganisms and drosophila flies during the development of sour rot. Microbial Ecology, 64(2), 416–430, Hall, M. E., Loeb, G. M., Cadle-Davidson, L., Evans, K. J., & Wilcox, W. F. (2018). Grape sour rot: A four-way interaction involving the host, yeast, acetic acid bacteria, and insects. Phytopathology®, 108(12), 1429–1442, Kelly, J.M. S. A. van Dyk, L. K. Dowling, G. Pickering and D.L. Inglis. (2020). Saccharomyces uvarum yeast isolate consumes acetic acid during fermentation of high sugar juice and juice with high starting volatile acidity. OENO One, vol. 54, pp. 199–211, McFadden-Smith W., 2010. New Initiatives in the Management of Grape Sour Rot. Ontario Ministry of Agriculture, Food and Rural Affairs