

Exploring the use of redox potential to predict fermentation outcomes in relation to initial juice conditions

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Introduction

Temperature and °Brix are the two main metrics used today by winemakers to monitor the health and progression of fermentations. By tracking these parameters, problematic fermentations can be identified, but often there is a delay between when the problem starts and when it is detected by these measures. Oxidation Reduction Potential (ORP) is a promising process parameter to inform wine fermentation progression (Liu et al. 2013, Killeen et al. 2018), which could have the benefit of earlier detection of issues. This is expected to benefit the industry, as stuck and sluggish fermentations cause significant economic losses for wineries around the world and implementing additional monitoring techniques could alleviate some of those losses.

ORP is a quantifiable measure of the tendency of molecules to gain or lose electrons and reports on all compounds in solution (Killeen et al. 2018). ORP is impacted by pH, dissolved oxygen, temperature, and chemical half reactions occurring in solution (Kucek et al. 2001).

The goal of this study was to evaluate the use of ORP as a monitoring tool to predict the outcome of fermentations. Varying media conditions were used, including challenging fermentation environments, to match outcomes with differences in ORP.

Materials and Methods

Fermentations were carried out in 1-liter bioreactors using Minimal Must Media (MMM). MMM was prepared as described in Spiropoulos et

al. 2000. except for altering glucose and fructose concentrations to 110 g/L, L-arginine to 0.2 g/L, and ammonium phosphate to 0.5 g/L. During fermentation, there was constant stirring, with temperature control at 22°C ± 1°C. Single strain fermentations of EC1118, CY3079, RC212, Elixir, and Montrachet yeast were carried out. Redox data was collected continuously throughout fermentation using Hamilton ORP probes, and °Brix were taken manually one or two times per day. Cell count and viability were taken on day 1 (inoculation = day 0), day 3, and when each fermentation reached 0 °Brix. Optical density was also taken every day, or every other day depending on the trial to monitor total cell populations. Trials included variations in pH (Figure 1), sugar content and temperature (Figure 2), and yeast strain (Figure 3).

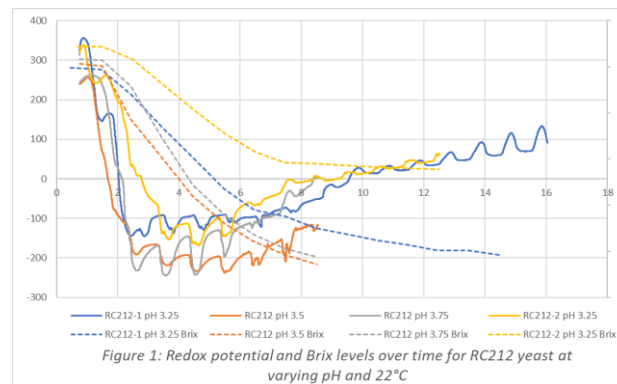


Figure 1: Redox potential and Brix levels over time for RC212 yeast at varying pH and 22°C

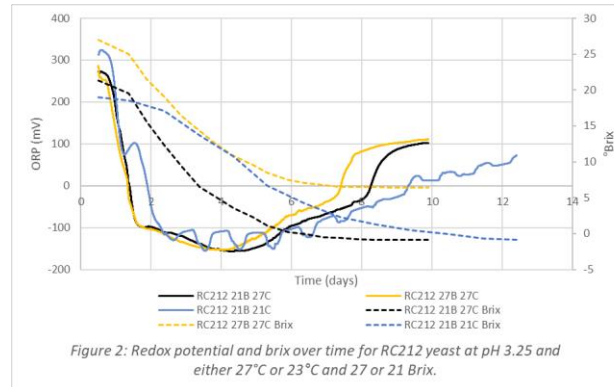


Figure 2: Redox potential and brix over time for RC212 yeast at pH 3.25 and either 27°C or 23°C and 27 or 21 Brix.

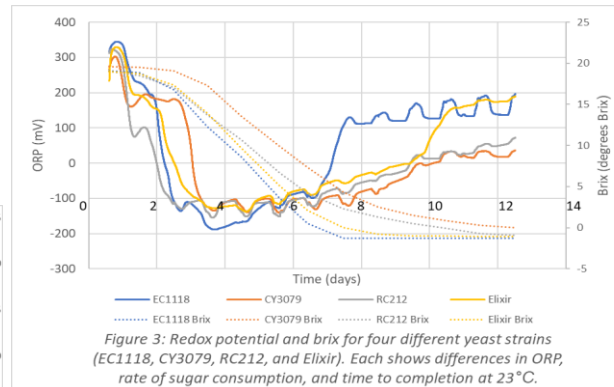


Figure 3: Redox potential and brix for four different yeast strains (EC1118, CY3079, RC212, and Elixir). Each shows differences in ORP, rate of sugar consumption, and time to completion at 23°C.

Conclusions

Preliminary results from this study show that redox data can be indicative of fermentation outcome and can be indicative of stuck or sluggish fermentations. Indications of problem fermentations are seen in the redox curves through a delayed drop

at the start of fermentations (Figure 1, see RC212 pH 3.25 day 1.5), not reaching as low a minimum value (Figure 1, see RC212 pH 3.25 day 2), and a rise in the curve prior to the fermentation's completion (Figure 2, see RC212 27B 27C day 5).

Winemakers may be able to use this technology as a “real-time” process parameter to gain information about the progression of their fermentation. Aberrations in ORP curves from normal fermentations being an early indicator that there may be issues with completion and allow for advanced monitoring or preventative actions.

Future work aims to monitor ORP in various fermentations, including those that fail for specific reasons. Variations will encompass pH and temperature, select nutrient limitation, variable metal ratios, yeast strain, and use of true grape juice. There is also a potential for computer-based modeling of ORP curves to aid in predicting fermentation outcomes.

References

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Acknowledgements

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