The Australian Wine Research Institute

Monitoring fermentation of red wine using near infrared spectroscopy

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Introduction

The application of near infrared (NIR) spectroscopy within the fermentation industry has been made possible by the development of robust NIR instruments and multivariate data analytical techniques (chemometrics). NIR spectroscopy does not need time consuming sample preparation or purification and gives analytical or quantitative results in a reduced time frame compared to other techniques. The objective of this work was to determine the feasibility of using NIR spectroscopy to monitor the changes in concentration of fermentation-related variables such as glucose plus fructose (G+F), yeast biomass (yeast count) and pH during red wine making.

Materials and methods

Duplicate fermentations of Shiraz must inoculated with three different yeast strains were conducted in rotary fermenters (750 kg) at 20˚C. Samples were taken from each fermenter daily for seven days of the fermentation and were clarified by centrifugation before scanning (400–2500 nm, visible and NIR) in transmission mode in a 1 mm path length cuvette, using a monochromator instrument (FOSS *NIRSystems6500)*. Chemical reference data were obtained using standard laboratory methods. Spectral data collection and manipulation were achieved using *VISION* software. Partial least square (PLS) regression models between spectral and reference data were developed using *The Unscrambler* software.

Results

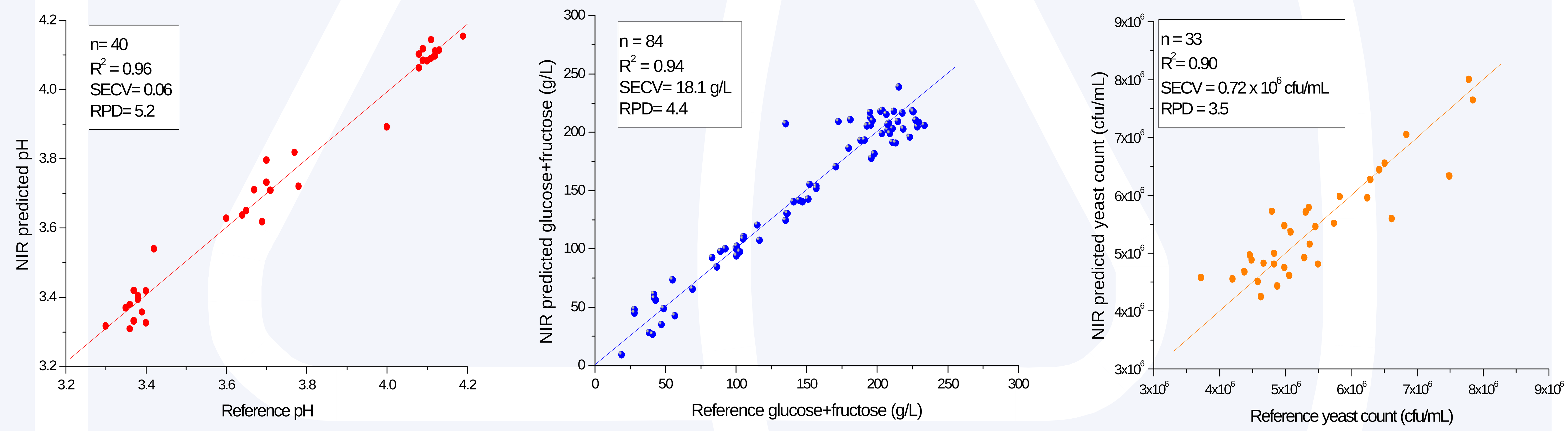
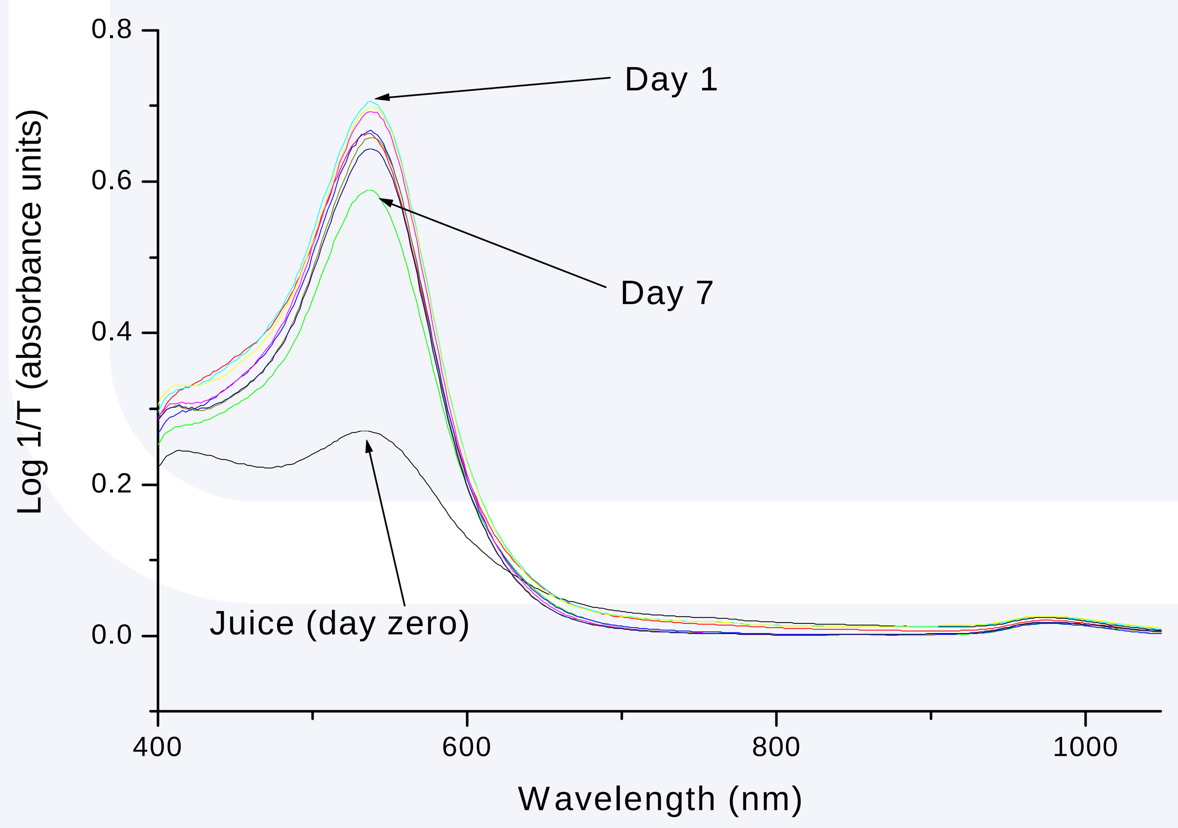


Figure 1. The relationship between reference and NR predicted values for pH, glucose+fructose and yeast count respectively.
n= number of samples, R^2 = coefficient of determination in calibration, SECV= standard error in cross validation, RPD= SD/SECV, values greater than three are considered as acceptable for analytical purposes.

Figure 1 shows the relationship between NIR and reference data for the fermentation-related variables. Coefficients of determination in calibration (R^2) and standard errors in cross validation (SECV) were respectively: for pH 0.96 and 0.06, for G+F 0.94 and 18.1 g/L and for yeast count 0.90 and 0.72 x 10^6 cfu/mL (note that day zero was not included). The standard error of cross validation (SECV) for G+F and pH are considered high relative to the range, however the residual prediction deviation (RPD) values suggest that the calibrations are quite useful for analytical application. The correlations between NIR data and reference data are likely to be due to collinear relationships (co-correlations) among chemical compounds in the wine matrix.

Figure 2. The visible and NIR spectrum of samples taken at various time during the fermentation.



The spectra of samples taken throughout the fermentation (Figure 2) showed most change in the visible regions around 550 nm. This is not surprising given that the extraction of anthocyanins, which absorb strongly in that part of the spectrum, will be expected to be one of the processes undergoing rapid change during red wine fermentation.

Conclusion

The results indicate that NIR spectroscopy is a promising technique for the rapid monitoring and measurement of fermentation-related variables during red wine making. Further studies will be needed to validate the accuracy and robustness of the calibration models developed.

Cooperative Research Centre for Viticulture
Australian Government
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