Fourier transform infrared spectroscopy: measuring grapevine nutrient status

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Opportunity for an alternative nutrient sampling method

Vineyard petiole analysis at 80% flowering (EL 25) is widely used to estimate grapevine nutrient status. Collecting a representative vineyard nutrition sample can assist with determining seasonal fertiliser requirements and managing long-term mineral deficiencies or toxicities.

Traditional commercial laboratory analysis requires approximately 100 petioles. In 2014, researchers at the National Wine and Grape Industry Centre (NWGIC) developed an alternative method for determining grapevine nutritional status using attenuated total reflectance Fourier transform infrared (ATR–FT–IR) spectroscopy. For this method, petioles are collected from the basal leaf opposite the flowering cluster (Figure 62), similar to samples sent to commercial laboratories. However, the ATR–FT–IR method is a rapid technique, reducing sample size and possibly reducing reporting turnaround.

Figure 62. Collecting petioles from the basal leaf opposite the flowering cluster.

As an initiative of the NSW DPI Viticulture Skills Development Program 2014–19, early-stage prototype software development is underway at the NWGIC to create an interface for the ATR–FT–IR spectrometer. The software will convert spectra results (Figure 63) into quantifiable figures for comparison against grapevine petiole nutrient standards. NSW DPI will demonstrate the software interface and ATR–FT–IR capability at the 2019 NSW DPI Spring Vine Health Field Days for industry feedback and validation.

Sampling and sample preparation

In Spring 2018, petiole samples were collected (at 80% flowering) from one Canberra district and two Tumbarumba vineyards. Five replicates were collected from Pinot Noir, Chardonnay (two samples), Shiraz and Riesling varieties (total 25 samples).

Each replicate comprised 100 vines and three petioles were collected from each vine (from the basal leaf opposite a flowering bunch). One petiole from each vine (100 petiole sample) was analysed at a commercial laboratory. Two petioles from each vine (200 petiole sample) were collected for comparison and analysed using ATR-FT-IR at the NWGIC.

Commercial laboratory samples were prepared according to the sample submission instructions. Samples for analysis via the ATR–FT–IR method were washed twice in water and further with phosphate-free detergent (Figure 64). After cleaning, the samples were oven dried at 60 ˚C. After three days, daily weighing of samples occurred until the sample weights were stable (Table 15). Once dry, petioles were ground using a coffee grinder (Figure 65) for 30 seconds.

Figure 63. Washed samples ready for drying.

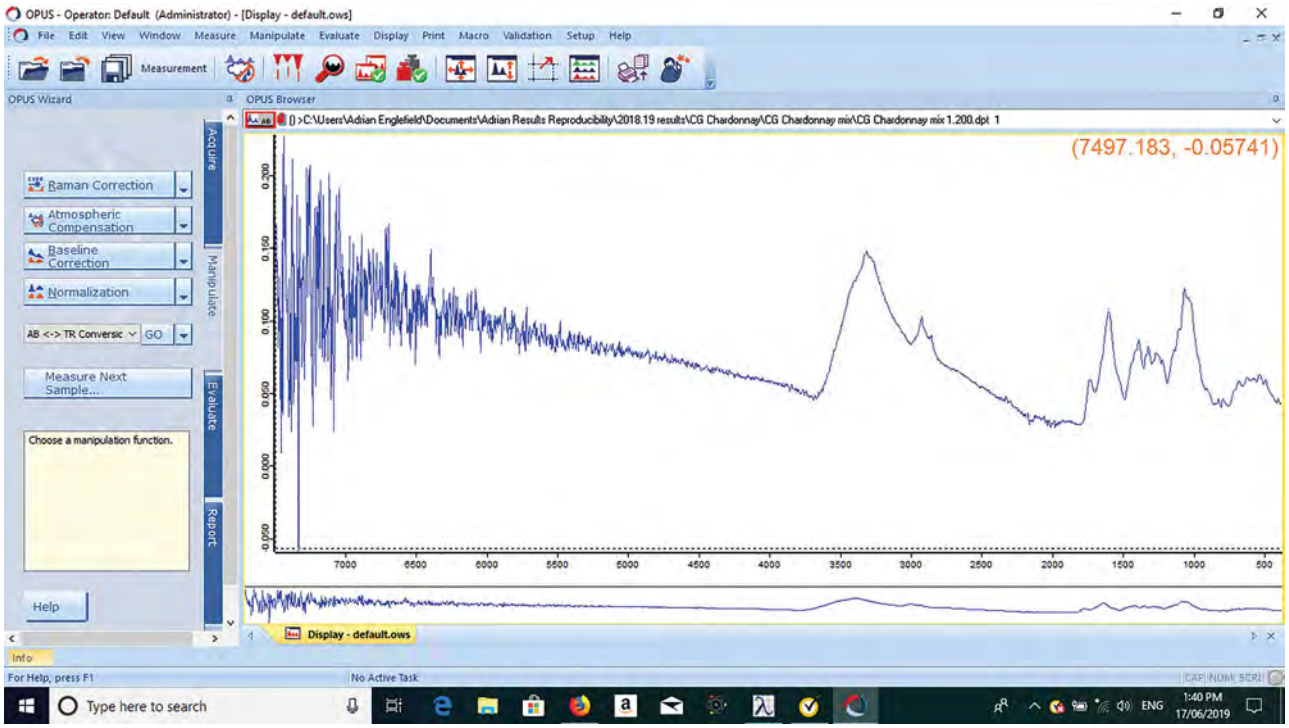

Figure 64. An example of spectra results that will be converted into quantifiable figures for comparison against grapevine petiole nutrient standards.

Figure 65. A coffee grinder for grinding dry petioles.

Table 15.Average petiole weights before and after drying.

Variety	Average weight (g) 200 petioles	Average weight (g) dried sample
Chardonnay (sample 1)	148.73	25.04
Chardonnay (sample 2)	140.32	24.08
Pinot Noir	116.48	18.50
Riesling	114.04	21.14
Shiraz	157.10	24.98

Results

Analysis of the 25 dried samples was conducted using Opus software and the ATR–FT–IR spectrophotometer at the NWGIC. The diamond internal reflection element was set at 40 ˚C and a background scan against air was conducted every 10 scans. ATR spectra for each sample were prepared by averaging 64 scans on each sample over the wavenumber range of 375–7,500 cm^{-1}.

Potential exists to measure 1–2 petiole samples. The ATR–FT–IR requires a sample size of approximately 0.1 gram, allowing for a much smaller sample size and precision vineyard sampling compared to commercial laboratory sampling. However, with a small sample, homogeneity (being representative of the total sample) must be considered.

Further work

Calibration of the software interface and ATR–FT–IR progression modelling is planned. Further work is required to fully assess the suitability and accuracy of this method as an alternative to commercial laboratory analysis. However, updates and demonstration of petiole sampling capability using the ATR–FT–IR technique will be held at the 2019 NSW DPI Spring Vine Health Field Days.

Acknowledgements

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Further reading

Smith JP, Schmidtke LM, Muller MC and Holzapfel BP. 2014. Measurement of the concentration of nutrients in grapevine petioles by attenuated total reflectance Fourier transform infrared spectroscopy and chemometrics. *Australian Journal of Grape and Wine Research,* 20: 299–309.