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(SHORT COMMUNICATION)

Estimation of grape Isabel's quality in pre-harvest based on spectral signature

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Abstract

A non-destructive technique, that estimate the quality of the grape, was used in a vineyard, aiming to evaluate the logistics of use a portable infrared equipment [NIRs] (Brimrose Corp, USA) incorporated in a motor vehicle. The equipment estimate in the field quantifies phenolic compounds from the Isabel grape through spectral data. The spectra were taken in clusters of grapes, in the 2017 and 2018 harvests. The Near Infrared instrumentations were connected to a laptop and positioned in a micro-tractor (Gator-John Deere) to travel the vineyard. The phenolic compounds were estimates using predetermined calibration models. This methodology proved to be promising for estimating the grape quality.

Keywords: NIR; Vineyard; Anthocyanin; Tannin; Polyphenols

1. Introduction

The phenolics of the vine play distinct roles during the development of the fruit until full ripeness. Important nutraceutical and pharmacological properties have also been attributed to grape phenolics, including antimicrobials, anticarcinogens and antioxidants [1].

The phenolic composition of grapes is a determining factor in the quality of juice and wine [2]. In order to determine the phenolic compounds of the grape, destructive chemical analyzes are usually carried out. These analyzes consume time, money and contaminating reagents. In addition, they only allow the quality control of some samples in batches [3].

Spectroscopic and chemometric techniques have been developed to determine the quality attributes of the fruit, in a precise and non-destructive way, through the joint use of multivariate statistical analysis methods. Spectroscopy is an alternative technique to conventional chemical analyzes that is particularly interesting for real-time monitoring of various components during the grape ripening process. Several studies carried out on different grape varieties have shown that near infrared [NIRs] and medium [MIRs] spectroscopy combined with multivariate analyzes were adequate to assess the evolution of phenolic compounds and ripeness, the main parameters of grape quality [1, 4, 5, 6,].

According to Cozzolino et al [7] NIRs is a powerful and non-invasive technique that is increasingly being applied in the food industry thanks to the development of cheaper, faster and more accurate sensors. Spectroscopy associated with chemometric methods allows that analytical results to be obtained systematically and with statistical reliability [8]. This development led to a broader application of spectroscopy as an accurate estimator of chemical concentrations within a given spectral range. These models are used to classify new samples after were validated. [9].

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Santos et al [10] developed predictive models, using infrared spectroscopy, for quality indicators (tannins, anthocyanins and total polyphenols) for red grapes The multivariate calibration models were developed using the partial least squares regression method [PLS]. Grape spectral modeling resulted in good predictions of anthocyanin (R2 = 0.99, RMSEP = 0.15), tannins (R2 = 0.99, RMSEP = 0.23) and total polyphenols (R2 = 0.99, RMSEP = 0.01). The constructed models showed a high correlation with the reference method and can be used to quantify new samples.

The aim of this study was to estimate the quality indicators of Isabel grape through the spectral signature using the calibration models determined by Santos et al [10] for tannins, anthocyanins and total polyphenols; and evaluate the logistics of taking spectra in the field, in pre-harvest, using a motorized vehicle and a portable infrared spectrophotometer.

2. Material and methods

Spectra collection took place in the 2017 and 2018 harvests in a vineyard installed in four 120 m linear Isabel planting lines being conducted in a typical double cordon, with a spacing of 3 m x 2 m.

A portable NIRs, Luminar 5030 system (Brimrose Corp, MD, USA) connected to a laptop and positioned in a Gator John Deere motor vehicle, were used to take spectra. The vehicle had an adequate size (1.52 m wide) to move between the lines without harming the plants (Figure 1). Spectral grape data were collected at the beginning of the pigmentation of the peel.

To achieve a better representation of the vineyard, three grape bunchs were sampled approximately every 12 meters. To obtain also a better representation of the internal content of the grape berries, in each cluster, three spectra were gathered from the upper, middle and lower regions of the clusters. The average spectrum of each cluster was calculated, totaling 70 grape clusters. The process of collecting and treating spectral data followed the same process that was carried out for the construction of the calibration model, where the spectra were collected in a transmittance mode and later on processed in absorbance mode by using the SNAP32 software (BRIMROSE, Maryland) incorporated into spectroscopic instrumentation. The second derivative of the spectra was used as a mean of improving the treatment of the data, in which the data dispersion is corrected, since through this it is possible, by superposition of spectra, a better individualization of the constituents, and even elimination of any interference of overlap spectra. Then, the spectral data were transferred to The Unscrambler software (CAMO, Norway) to estimate of phenolic compounds based on the calibration models built by Santos et al [10].

Figure 1 Demonstration of spectra taking in the field, (a) detail of the integration of equipment to Gator. (b) Collection of the spectrum using the NIR spectrophotometer

3. Results and discussion

The instrumentation and the software used in pre-harvest to acquire spectral data were well integrated, being the spectra taken with agility. This technology allows the winemaker to perform routine evaluations to estimate phenolic compounds, to determine their maturation profile, and with this, the best time for harvest.

In the estimation of phenolic compounds collected in the field, in pre-harvest, the anthocyanin showed an average value of 0.76 $mg.g^{-1}$ and standard deviation of 0.04 $mg.g^{-1}$. The tannin content showed an average value of 4.75 U.A. with standard deviation of 0.6 U.A. The average polyphenol content was 1.09 $U.A.g^{-1}$ with standard deviation of 0.04 $U.A.g^{-1}$. The estimated values were within the data range determined by reference analysis, in the grape samples, for the construction of the model, where the anthocyanin ranged from 3.0 to 0.33 $mg.g^{1}$; tannin between 13.19 and 0.01 U.A. and the total polyphenols between 2.34 and 0.007 $U.A.g^{-1}$.

4. Conclusion

Based on the results achieved in this study, the use of spectroscopy, in the near infrared range, presented great potential for application in the field to determine the quality parameters studied in real time. The instrumentation and software used in pre-harvest were well integrated, making it possible to quickly see the variability of quality indicators before harvest.

Compliance with ethical standards

Disclosure of conflict of interest

The author declare that there was no conflict of interest.

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