

Abstract

Project Code : MRG6180016

Project Title : Non-Destructive Measurement of Sugarcane Quality Using a mobile Near Infrared Instrument

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Project Period : 2 May 2018 to 1 May 2020

Abstract:

Near infrared spectroscopy can be applied as a rapid and non-destructive method for monitoring sugarcane quality after determining the precision and accuracy of the approach and model to be used for evaluating stems. The objectives of this study are (1) to compare the performance of different integration times including short-time (200ms), mid-time (300ms) and long-time (400ms), (2) to evaluate the model performance of different number of scanning positions using partial least squares (PLS) analysis, (3) to compare the performance of the different sample preparation including original sample and wax removed sample, and (4) to clarify the spectral differences, repeatability, and reproducibility of Vis/SWNIR spectra caused by waxy types on sugarcane surface. The experiments under controlled temperature of cane stalks were done to fulfill objective (1)-(4). Methodology and results are described as follows.

For achieving the optimum integration time to fulfill the objective (1), The samples were scanned with different integration times (200, 300, and 400 ms), and the spectra were pre-treated using different pre-processing techniques. The models were constructed using a sample set of three sample sections (i.e., bottom, middle, and top of the sugarcane stalk). The fibre content models were established based on both combined sample sections (CSS model) and individual sample sections (ISS model) obtained from the combination of three sample sections and an individual sample section, respectively. The results showed that the models that were developed using raw spectra with integration time of 300 ms had the best performance. This model had coefficients of determination of the prediction set (r^2) of 0.75, 0.81, 0.81 and 0.71 and root mean square errors of prediction (RMSEP) of 0.81, 0.63, 0.80 and 0.73% fibre for the CSS model and bottom section, middle section, and top section of the ISS model, respectively. These results indicated that the models could be used for screening. Moreover, it was observed that the bottom section model had the lowest RMSEP. The model can be used as a rapid protocol for predicting the fibre content of sugarcane stalks,

making it a useful method for a breeder to screen the fibre content in the field when monitoring during breeding programmes.

For objective (2) – (3), near infrared spectra were collected using a portable near infrared instrument incorporating a wavelength region of 730–1000 nm. To achieve an effective sampling technique, the investigated cane samples included stems with original cane surface and stems with cane wax removed surface. Results revealed that calibrations based on spectra recorded at only 1-position (1-position spectra) of original samples were poor, while calibrations based on stems with wax removed were acceptable for screening with RMSEP values of 1.2%Pol. Also, the 2-position averaged spectra of non-removed wax samples provided fair models, while 4- and 8-position averaged spectra gave good results with R^2 of 0.78–0.82, r^2 of 0.78–0.82, RMSEP of 1.2%Pol to 1.4%Pol and RPD of 2.1 to 2.4, respectively. The calibration model developed from removed-wax samples at positions 1-, 2-, 4- and 8-averaged spectra rendered effective performances with R^2 of 0.73–0.82, r^2 of 0.73–0.84, RMSEP of 1.2%Pol to 1.5%Pol and RPD of 2.1 to 2.5. Hence, the author concluded that 1-position spectra with removed-wax samples were convenient and suitable for the measurement of cane stalk Pol value.

To obtain the repeatability and reproducibility for objective (4), Principal component analysis (PCA) was applied to examine the differences in the spectra scanned from 180 samples, including 3 types of waxy type: white, black, and mixed black and white. Seven widespread pretreatments were employed to reduce the effect of the waxy types. Results show that the spectra of the samples with each waxy type was separated in groups and standard normal variate (SNV) pretreatment gave the best results. Meanwhile, the standard deviation of absorbance values, at the wavelength of 760, 904 and 970 nm of 3 samples, was used for assessing the repeatability and reproducibility. The samples where the waxy covers were removed provided a lower standard deviation of absorbance values of spectra than the best pretreated spectra that used SNV of the samples that retained its waxy covers by one to six times. Thus, the waxy material on cane surface should be removed before collecting spectra.

The article entitled “Prediction of the fiber content of sugarcane stalk by direct scanning using visible-shortwave near infrared spectroscopy” was published in *Vibrational Spectroscopy* (SCI Q3) Vol. 101(2019) 71–80, the article entitled “Effect of waxy material and measurement position of a sugarcane stalk on the rapid determination of Pol value using a portable near infrared instrument” was published in *Journal of Near Infrared Spectroscopy* (SCI Q3) Vol. 26(5) 287–296, and the article entitled *Effects of Waxy Types of a Sugarcane Stalk Surface on the Spectral Characteristics of Visible-Shortwave Near Infrared measurement* was accepted to be published in *ENGINEERING JOURNAL* (SCOPUS) Vol. 23(1).

Keywords: Sugarcane stalks, Visible-shortwave near infrared spectroscopy, portable type instrument, wax, Sugarcane quality.

3-5 words