Quality parameters evaluation in 'Tommy Atkins' mango using a handheld ultra-compact near infrared spectrometer

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Mango production is an important activity worldwide. However, problems related to fruit quality have limited its consumption. Nowadays, the development of non-destructive, reliable, accurate, fast and robust methods is essential to ensure a better quality of fruit offered to consumers. The development of new technologies used for the construction of NIR spectrometers has allowed to reduce the size and cost of these devices significantly. An important example are the spectrometers based on the linear variable filter technology which requires no moving parts, consequently leading to smaller and more rugged devices. These instruments are more suitable for being transported outside of the laboratory for analysis in the field or packinghouses. The aim of this study was to evaluate the potential of a new handheld ultra-compact near infrared (NIR) spectrometer (MicroNIR 1700, JDSU, CA, USA) for rapid and non-destructive quality analysis of 'Tommy Atkins' mango.

A total of 250 'Tommy Atkins' mangoes were harvested, washed and randomly divided in 10 groups with 25 fruit. NIR spectral data and reference data were obtained at harvest and every two days during storage for 18 days at 24ºC (±1°C). The quality parameters evaluated were soluble solids (SS), dry matter (DM), titratable acidity (TA) and pulp firmness (PF). For spectra acquisition, six separate measurements using the MicroNIR spectrometer were carried out on each mango by means of six points distributed along the axial region, being three points located on each side of the fruit. The measurements were performed by positioning the spectrometer directly on fruit skin. The six spectra were averaged to provide a mean spectrum for each fruit. Reference analyses were accomplished using pieces of the fruit regions previously probed by the NIR portable spectrometer. Different spectral pre-processing methods were evaluated: first and second derivatives using Savitzky-Golay smoothing filter, Standard Normal Variate (SNV), Enhanced Multiplicative Signal Correction (EMSC) and the combination of the SNV with derivatives using Savitzky-Golay smoothing filter. Samples were divided into calibration and prediction sets using the SPXY (Sample set Partitioning based on joint **x**–*y* distances) algorithm. Multivariate calibration models were developed using Partial Least Squares (PLS) regression and two different strategies: (1) using the full spectral range (950-1650 nm); (2) using the variables selected by the Jack-Knife algorithm which selects only the significant regression coefficients.

Predictive performance for all the models was better when SNV was applied as pre-processing method and the full spectra was used for DM, TA and PF determination. Only for SS the best result was achieved using the Jack-Knife algorithm for wavelength selection. Coefficient of determination values in the external validation step (R^2_v) were 0.92, 0.67, 0.58 and 0.72 for SS, DM, TA and PF, respectively. Values for the root mean square errors of prediction (RMSEP) were 0.55 ºBrix for SS (range: 5.9-14.1 ºBrix), 0.51% for DM (range: 9.5-15.8%), 0.18% citric acid for TA (range: 0.22-1.39% citric acid) and 12.2 N for PF (range: 16.2-115.7 N). The results show the feasibility of using the new NIR handheld spectrometer to determine quality parameters in 'Tommy Atkins' mango.

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Novelty

Mango quality was evaluated by NIR spectroscopy using the smallest commercial handheld device containing the linear variable filter technology available on the market. The results showed that the MicroNIR spectrometer can be used to predict soluble solids, dry matter, titratable acidity and pulp firmness in intact mango fruit with acceptable accuracy. The ultra-compact NIR spectrometer is a promising instrument that can be used by growers, shippers, and retailers to evaluate and monitor mango fruit quality offered to consumers.