# Evaluation of a handheld ultra-compact NIR spectrometer for rapid and non-destructive determination of apple fruit quality

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## Abstract

Benchtop and portable devices based on near infrared (NIR) spectroscopy are increasingly used to evaluate the quality parameters of fruits. This study aims to compare the analytical performance of a benchtop spectrometer (XDS) and a handheld ultra-compact spectrometer (MicroNIR) and to investigate calibration transfer between these devices for quality parameters of apples (soluble solids content, titratable acidity, pulp firmness, and starch-iodine index). Regression analyses were performed on a subset of apples measured with both spectrometers. The coefficient of determination ($R^2$) and the root mean square error of cross-validation (RMSECV) values obtained with Partial Least Squares (PLS) models were similar, which suggests that MicroNIR offers similar performance to the XDS device. For example, for soluble solids content, it was observed a $R^2$ = 0.89 with a RMSECV = 0.62 and a $R^2$ = 0.91 with a RMSECV = 0.57 for XDS and MicroNIR respectively. For the transfer, calibration models were built using XDS spectra and different regression methods. The best performances were obtained with Least Squares Support Vector Machines (LS-SVM). The Direct Standardization method was applied to achieve calibration transfer. Only two transfer samples were enough to significantly reduce the root mean square error of prediction (RMSEP) values with a relative reduction varying from 74% to 93% for PLS and Multiple Linear Regression (MLR) models respectively. It showed the potential of a simple calibration transfer method to allow the use of historical database registered with benchtop instrument.