

Determination of soluble solids content in oranges using visible and near infrared full transmittance hyperspectral imaging with comparative analysis of models

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Abstract

The feasibility of using visible and near infrared full transmittance hyperspectral imaging for predicting soluble solids content (SSC) in oranges has been assessed. A combination of competitive adaptive reweighted sampling and successive projections algorithm (CARS-SPA) was used to select the effective wavelengths. Size of fruit was used as a compensation factor to establish a calibration model coupled with spectral information. Full transmittance spectra and physiochemical parameters (SSC and size) of samples were extracted. The potential outliers in samples were eliminated by Monte-Carlo outlier detection method. Effective wavelengths were selected by CARS algorithm and the newly proposed CARS-SPA combination method. Three types of models including partial least squares (PLS), multiple linear regression (MLR) and least squares-support vector machine (LS-SVM) were established for SSC analysis of fruit based on different inputs. Results indicated that all models can realize the satisfactory prediction of SSC in oranges. Ranges of coefficient of determination (R^2_{pre}) and root mean square error of prediction ($RMSEP$) were 0.88-0.89 and 0.48-0.48 % for PLS models, 0.83-0.85 and 0.49-0.55 % for MLR models, 0.86-0.90 and 0.40-0.48 % for LS-SVM. Compared among all SSC analysis models, CARS-SPA was a powerful effective wavelength selection combination and CARS-SPA-LS-SVM model with size had the optimal prediction accuracy ($R^2_{pre} = 0.90$, $RMSEP = 0.40$, $RPD = 3.18$). Overall, the results revealed that full transmittance hyperspectral imaging can be used to non-invasively to rapidly measure the SSC of oranges. A robust and accurate model could be established based on CARS-SPA-LS-SVM method with size compensation. These results may provide a useful reference for assessment of other internal quality attributes, such as acidity, of the thick-skinned fruit.