Detection of internal defect of apples by a multichannel Vis/NIR spectroscopic system

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Abstract

This paper reports on nondestructive detection of internal defect in apples by using a new noncontact multichannel spectroscopic system in semi-transmittance mode for the visible and near-infrared (Vis/NIR) range of 550-1,650 nm. The specially designed multichannel system consists of six optical fibers arranged in a 360-degree configuration for improved evaluation of each fruit. Spectra were acquired for 430 'Honeycrisp' apples, 243 of which were good (defect free) and 187 internally defective. To assess the effect of fruit orientation on defect detection, each apple was measured in three orientations (i.e., the stem-end facing the light source (A), the calyx end facing the light source (B) and the stem-calyx axis being perpendicular to the light source(C)). Classification models based on partial least squares discriminant analysis (PLSDA) were established for spectra of each detection fiber and mean spectra of the six detection fibers, to compare their performance for internal defect detection. Results showed that classification results varied with detection fiber and fruit orientation. Mean spectra for each fruit orientation gave consistently better classifications, with the overall accuracies of 91.5%, 89.2% and 93.1% for orientations A, B and C, respectively. Moreover, the best PLSDA models had lower misclassification rates for good apples (4.3%) than for defective apples (10.0%). Furthermore, significantly better classification results for mildly defective apples were obtained when using mean spectra than using spectra of each detection fiber. The multichannel Vis/NIR spectroscopic system is thus advantageous for detection of internal defects, especially those localized ones, in apples.