Early detection of eggplant fruit stored at chilling temperature using different non-destructive optical techniques and supervised classification algorithms

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Abstract

Eggplant fruit is a chilling injury sensitive vegetable and should not be stored at lower than 12 °C postharvest, although fruit are often placed in temperatures as low as 0–5 °C. For this reason, a rapid early detection of eggplants previously stored at chilling temperatures would allow early removal of those fruit from the market. Eggplant fruit (cv. Fantasy) were stored either at 2 °C (chilling injurious temperature) or at 12 °C (safe storage temperature) for 10 days. Every 2 days, fruit from each group were sampled and left at room temperature, for one additional day. Color measurements in the CIE L*a*b* mode and reflectance data in the wavelength range 360–740 nm, Fourier Transform (FT)-NIR spectra (800–2777 nm) and hyperspectral images at the visible (400–1000 nm) and near infrared (900–1700 nm) part of the electromagnetic spectrum were also acquired on each fruit. Three supervised algorithms; partial least square (PLS), supervised vector machine (SVM) and k-nearest neighbor (kNN) were applied to classify fruit according to the storage temperature. Chilling injury (CI) was subjectively evaluated, according to the presence of black seeds or of brown discolored flesh area. According to the results, although chilling injury symptoms started being evident only after the 4th day of storage at 2 °C, it was possible to discriminate fruit earlier, since day 2, by processing the FT-NIR spectral data with the SVM classifier (100 and 92% non-error-rate (NER)) in calibration and cross validation, respectively) in the whole period data set. Color or FT-NIR spectral data classified with PLSDA permitted relatively good classification of fruit (>83% accuracy) since the 4th day of storage, while L, C, H° color measurements or Vis-NIR hyperspectral imaging data combined with PLSDA generate trustworthy models only after the 6th day of storage. On the other hand, NIR hyperspectral imaging technique

and kNN classification algorithm were incapable to separate the fruit either accurately or consistently. These results indicate a good potential of adapting selected protocols, in terms of technique, processing of the raw data and supervised classification algorithm, in order to minimize postharvest losses induced by the improper temperature management of chilling sensitive fruit, such as the eggplants.