Evaluation of Near-infrared (NIR) Spectrum Calibration Model for a Non-invasive Assessment of Internal Fruit Qualities in Apple

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Non-invasive assessment of fruit qualities such as sugar or starch content has become broadly used in fruit industry. Given that fruit ripening not only determines a proper harvest time but affects the storage period as well, it is important for farmers to monitor fruit internal qualities in both pre- and post-harvest period. To establish the near-infrared (NIR) spectrum calibration model on the fruit quality, we undertook regression modeling analysis from a dataset measured with a broad NIR wavelength range in apple fruit. 'Fuji' apple fruit were collected at three different pre-harvest time points (H-30, 30 days before harvest; H-15, 15 days before harvest; Harvest). NIR spectrum was measured in each fruit using a portable NIR spectrophotometer (H-100F, Sunforest, Republic of Korea). Total soluble solids (TSS) contents were analyzed using a digital refractometer (PR-32α, Atago Co. Ltd., Japan). Fruit dry matter content (DMC) was measured by drying at 75°C in a drying oven at least 24 hours until fruit get a constant weight. The gradient of TSS content was induced from fruit internal temperature ranged from 3.5 to 40.6°C and the responsive NIR spectrum (800 to 920 nm) was obtained for further analysis. At 30 days before harvest, fruit DMC was highly related to NIR spectrum. The regression analysis indicated that the coefficient of determination ($R^2$) was 0.94 in DMC calibration model whereas TSS model was relatively less predictable ($R^2 = 0.85$). The accuracy of NIR spectrum calibration increased in both TSS and DMC according to the ripening stage of fruit. A strong calibration model was constructed to estimate fruit internal temperature with a very high $R^2$ value (0.99) and a reliable value of standard error of correlation (SEC) (0.88). Our results suggest that the fruit TSS and DMC can be reliably predicted using a wide range of NIR spectrum. However, a proper validation of calibration model must be further demonstrated.

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