Title Measurement of the optical properties of fruits and vegetables using spatially resolved hyperspectral diffuse reflectance imaging technique

Author Jianwei Qin and Renfu Lu

Citation Postharvest Biology and Technology, Volume 49, Issue 3, September 2008, Pages 355-365

Keywords Hyperspectral imaging; Spatially resolved spectroscopy; Diffuse reflectance; Optical properties; Diffusion theory model; Fruits; Vegetables; Light penetration depth

Abstract

This paper reports on the measurement of the optical properties of fresh fruits and vegetables over the visible and short-wave near-infrared region (500–1000 nm) using a spatially resolved steady-state diffuse reflectance technique. A hyperspectral imaging system in line scan mode was used to acquire spatially resolved diffuse reflectance images from the samples of apple (three varieties), peach, pear, kiwifruit, plum, cucumber, zucchini squash, and tomato (at three ripeness stages) over the spectral range of 500–1000 nm. The absorption and reduced scattering coefficients of the samples were determined from the spatially resolved scattering profiles using inverse algorithms for a diffusion theory model. Spectra of the absorption coefficient were featured by major pigments (chlorophyll, anthocyanin, and carotenoid) and water in the samples, whereas spectra of the reduced scattering coefficient generally decreased with the increase of wavelength. Values of the absorption and reduced scattering coefficients varied greatly among the test samples. Large differences in the absorption spectra were observed for the tomatoes of three ripeness stages (green, pink, and red), and their ripeness was correctly classified using the ratio of the absorption coefficient at 675 nm (for chlorophyll) to that at 535 nm (for anthocyanin). Values of the reduced scattering coefficient positively correlated with the firmness of tomatoes at individual wavelengths of 500–1000 nm, with the maximum correlation of 0.66 being obtained at 790 nm. Light penetration depths, defined as the depths at which the incident light was reduced by 99%, were estimated to be between 0.97 and 6.52 cm for the fruit and vegetable samples over the wavelength range of 500–1000 nm; they were influenced by major pigments in the plant tissue. The spatially resolved steady-state diffuse reflectance technique provides a convenient and efficient means for measuring the optical properties of turbid food and agricultural products.