Relationship between optical properties and soluble sugar contents of apple flesh during storage

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Abstract

Soluble solids (SS) in fruit are mainly composed of soluble sugars. This research aims to further the understanding of the detection mechanism of soluble solid content (SSC) based on optical technology by exploring the relationship between optical properties and soluble sugar contents. The total reflectance and total transmittance at 400–1050 nm of Fuji apple flesh stored at 25 °C for 50 d and 0 °C for 150 d were collected by an automatic integrating sphere system. The absorption coefficient (μ_a) and reduced scattering coefficient (μ_s') were obtained by iteratively solving the radiative transfer equation using the inverse adding doubling algorithm. The relationship of μ_a and μ_s' with the contents of SS, total soluble sugars, fructose, glucose and sucrose were quantitatively analyzed at different wavelengths, and prediction models were established by partial least squares regression (PLSR). The results showed that the changes in μ_a, μ_s', SSC and soluble sugar content presented similar trends during storage at the two test temperatures. As the storage time increased, the decreases in μ_a and μ_s' were accompanied by declines in SSC and soluble sugar content. In addition, μ_a and μ_s' at 550–1050 nm were both positively correlated with SSC and soluble sugar content, with correlation coefficients (r) of 0.834-0.992 and 0.737-0.981, respectively. Compared with the correlations at 550–780 nm, the correlations at 780–1050 nm between μ_a and SSC and soluble sugar content were enhanced, while the corresponding correlations with μ_s' were gradually weakened. In addition, SS was most strongly correlated with sucrose among the three types of soluble sugars. SS and sucrose had closer relationship with μ_a and μ_s' than fructose and glucose with μ_a and μ_s'. Moreover, their prediction models also performed better than the models for fructose and glucose, with R_p^2 values of 0.731-0.804. Thus, the prediction of SSC based on Vis-NIR optical technology may be related to the high correlations between the absorption and scattering properties and the sucrose content.