Using absorption and reduced scattering coefficients for non-destructive analyses of fruit flesh firmness and soluble solids content in pear (Pyrus communis 'Conference')— An update when using diffusion theory

ABSTRACT

Quality attributes of fruit determine its acceptability by the retailer and consumer. The objective of this work was to investigate the potential of absorption (μ_a) and reduced scattering (μ_s') coefficients of European pear to analyze its fruit flesh firmness and soluble solids content (SSC). The absolute reference values, μ_a^* (cm−1) and $\mu_s'^*$ (cm−1), of pear were invasively measured, employing multi-spectral photon density wave (PDW) spectroscopy at preselected wavelengths of 515, 690, and 940 nm considering two batches of unripe and overripe fruit. On eight measuring dates during fruit development, μ_a and μ_s' were analyzed non-destructively by means of laser light backscattering imaging (LLBI) at similar wavelengths of 532, 660, and 830 nm by means of fitting according to Farrell's diffusion theory, using fix reference values of either μ_a^* or $\mu_s'^*$. Both, the μ_a^* and the μ_a as well as $\mu_s'^*$ and μ_s' showed similar trends. Considering the non-destructively measured data during fruit development, μ_a at 660 nm decreased 91 till 141 days after full bloom (dafb) from 1.49 cm−1 to 0.74 cm−1 due to chlorophyll degradation. At 830 nm, μ_a only slightly decreased from 0.41 cm−1 to 0.35 cm−1. The μ_s' at all wavelengths revealed a decreasing trend as the fruit developed. The difference measured at 532 nm was most pronounced decreasing from 24 cm−1 to 10 cm−1, while at 660 nm and 830 nm values decreased from 15 cm−1 to 13 cm−1 and from 10 cm−1 to 8 cm−1, respectively. When building calibration models with partial least-squares regression analysis on the optical properties for non-destructive analysis of the fruit SSC, μ_a at 532 nm and 830 nm resulted in a correlation coefficient of R = 0.66, however, showing high measuring uncertainty. The combination of all three wavelengths gave an enhanced, encouraging R = 0.89 for firmness analysis using μ_s' in the freshly picked fruit.