Validation study for measuring absorption and reduced scattering coefficients by means of laser-induced backscattering imaging

ABSTRACT

Decoupling of optical properties appears challenging, but vital to get better insight of the relationship between light and fruit attributes. In this study, nine solid phantoms capturing the ranges of absorption (μ a) and reduced scattering (μ s ') coefficients in fruit were analysed non-destructively using laser-induced backscattering imaging (LLBI) at 1060 nm. Data analysis of LLBI was carried out on the diffuse reflectance, attenuation profile obtained by means of Farrell's diffusion theory either calculating μ a [cm $^{-1}$] and μ s ' [cm $^{-1}$] in one fitting step or fitting only one optical variable and providing the other one from a destructive analysis. The nondestructive approach was approved when calculating one unknown coefficient non-destructively, while no ability of the method was found to analysis both, μ a and μ s ', non-destructively. Setting μ s ' according to destructive photon density wave (PDW) spectroscopy and fitting μ a resulted in root mean square error (rmse) of 18.7% in comparison to fitting μ s ' resulting in rmse of 2.6%, pointing to decreased measuring uncertainty, when the highly variable μ a was known. The approach was tested on European pear, utilizing destructive PDW spectroscopy for setting one variable, while LLBI was applied for calculating the remaining coefficient. Results indicated that the optical properties of pear obtained from PDW spectroscopy as well as LLBI changed concurrently in correspondence to water content mainly. A destructive batch-wise analysis of μ s ' and online analysis of μ a may be considered in future developments for improved fruit sorting results, when considering fruit with high variability of μ s '.

Keyword: Absorption; European pear; Fruit quality; Phantom; Reduced scattering coefficien; Scattering; Spatially resolved spectroscopy