# Microstructure affects light scattering in apples

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## Abstract

The success of long-term storage of apples under controlled atmosphere (CA) depends, amongst others, on the gas exchange properties of the fruit. As gas exchange is effectively dictated by the microstructure of the fruit, the ability to obtain microstructure data becomes critical to improve storage solutions. The current study complements scattering measurements by means of spatially resolved spectroscopy (SRS) with 3D microstructure data obtained with contrast enhanced X-ray computed micro-tomography (micro-CT). Complementary measurements with both techniques were performed on apples of different cultivars that have different optimal storage conditions and different fleshy microstructure ('Kanzi', 'Braeburn', 'Jonagold' and 'Golden Delicious'). The mean reduced scattering coefficients of the subsurface tissue were calculated from SRS measurements in the 750 nm to 900 nm range at specific equatorial positions on the intact apple. Microstructural parameters such as cell size (equivalent spherical diameter), anisotropy, elongation, flatness, sphericity, object count, porosity as well as pore surface density were quantified and analyzed at the same spot up to 3 mm in depth from the fruit surface. A partial least squares regression model using the microstructural parameters as the different variables to predict the reduced scattering coefficient was built in order to identify the parameters contributing most to this relation. Both mean porosity and pore surface density showed the largest absolute regression coefficients. Furthermore, plotting the reduced scattering coefficient against mean porosity and pore surface density produced a linear relationship between the two parameters with an $R^2$ of 0.89 for both sets of data. The linear relationship suggests that the porosity of individual fruit can be determined via optical SRS measurements. This could allow to sort fruit based on their porosity, thus promoting fine tuning of the storage strategies by reducing variation in the porosity and gas exchange rate of the fruit being stored together.