Title 3-D virtual fruit microstructure modelling

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Citation ISHS Acta Horticulturae 858:473-477. 2010.

Keyword transmission electron microscopy; tomography; multiscale modeling; multi component modeling; cell wall; pore network

Abstract

The traditional approach to study fruit from a macroscopic perspective is being redirected to the microscopic level as our understanding of the lower scale increases. The microstructural components (cells, cell walls and air voids) of fruits determine the fruit's mechanical and transport properties. However, this relationship is unclear to date. Microscale models offer a means to compute the mechanical material behaviour and transport properties in the true microscopic geometry of the fruit. This calls for the 3-D characterization and representation of fruit tissue components. Cells, cell walls and air voids of cortex tissue of pear (cv. 'Conference') fruit were defined based on imaging at submicron resolution by means of transmission electron microscopy (TEM) and synchrotron radiation X-ray computed microtomography. The cell wall thickness was determined from TEM images using digitization procedures. An ellipsoid tessellation algorithm was developed to cut individual cells from the microtomography images. The air voids were a result of the natural stacking of the ellipsoids in the 3-D microstructural domain. Validation of the structures was achieved by means of conventional segmentation of the original microtomographs into air voids and cells, and calculating the geometric characteristics of the resulting networks. The resulting geometric solid model comprising the three principal components was modelled in ANSYS (ANSYS, Inc., Canonsburg, USA) working environment. The model geometry will be used in finite element or finite volume in silico simulations of gas and water transport and mechanical deformation of the microstructures. The advantages of the novel method are that individual cells are segmented and the tool provides a framework for in silico generation of fruit structures.