Title Multiscales modeling of gas transport in fruit relation to CA storage disorders

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Abstract

A multiscale gas exchange model was developed to perform in silico experiments to evaluate the effect of external storage conditions, fruit size and maturity on the intra-cellular respiration and risks of occurrence of physiological disorders. Pear fruit was chosen as a model system. The approach consists of interconnected models that describe the transport phenomena at the macro and the microscale. First, macroscale model simulations of the respiratory gas concentrations in the critical fruit region (region of the lowest and highest O_2 and CO_2 concentration of intact fruits) were performed. This region was considered to be more susceptible to physiological disorders caused by anoxia and high CO_2 partial pressure. Next, the microscale model was applied to compute the corresponding intra-cellular metabolic gas concentration. The in silico study revealed that O_2 concentration of optimally picked pear stored at typical controlled atmosphere condition (2.5 kPa O_2, 0.7 kPa CO_2 at -1°C) were higher than the Michaëlis-Menten constant for cytochrome c oxidase Km,c, the rate limiting enzyme of the respiration pathway. In contrast to small pears, large pears and extreme low O_2 storage conditions lead to O_2 concentrations well below the Km,c. This most probably leads to fermentation and physiological disorders which have been observed under such conditions. Ripening of the fruit increased the risk of physiological disorders since increased respiration resulted in anoxia in the fruit center even at the typical storage conditions.