Apparent respiratory quotient observed in headspace of static respirometers underestimates cellular respiratory quotient of pear fruit

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Postharvest Biology and Technology, Volume 162, April 2020, 111104

Abstract

A three-compartment non-equilibrium gas transport model of 'Conference' pear fruit under controlled atmosphere (CA) storage was developed. The model fruit tissue consists of cells, in which the concentrations of respiratory gasses can show gradients, and intercellular space, in which gasses are uniformly distributed. Non-equilibrium of gas concentrations in the cell compartment and intercellular space is assumed. A respiration model based on Michaelis-Menten respiration kinetics without inhibition of respiration by CO_2 and incorporating down-regulation of the maximal O_2 consumption rate in response to O_2 was developed. Conversion of CO_2 dissolved in the cell compartment to hydrogen carbonate at a constant pH of 5.0 was included. The model was validated based on experimental data of 'Conference' pear fruit during a complete depletion experiment starting from 3.58 mol m^{-3} O_2 and 0.00 mol m^{-3} CO_2. Model predictions match experimental observations well. Gas concentrations in the cell compartment were found to be in equilibrium with the gas concentrations in the intercellular space. The model was used to calculate apparent respiration rates and RQ as if measured in the storage headspace. Apparent values were compared to actual values in the fruit cells and it was found that apparent respiration rates and RQ, calculated based on headspace measurements, underestimated the actual respiration rate and respiratory quotient in the fruit cells. Relative differences of 4 %, 41 % and 41 % were found for the apparent O_2 consumption rate, CO_2 production rate and RQ, respectively. This affects the design of commercial RQ based DCA systems.