Modelling respiration rate of dragon fruit as a function of gas composition and temperature

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Scientia Horticulturae 263: 109138. (2020)

Abstract

The application of controlled atmosphere and modified atmosphere packaging to extend the shelf life of dragon fruit requires insight into the respiration behaviour of the fruit under different storage conditions. To this end, this study focused on characterising the respiration kinetics of dragon fruit using a dynamic closed depletion system. An integrated data analysis was performed using a Michaelis-Menten based respiration model extended with an Arrhenius equation to account for the effects of O_2, CO_2 and temperature. Iterative analysis of the data using different model versions eventually revealed that the classical Arrhenius equation did not suffice to explain the observed respiration behaviour over the whole temperature range (2 °C–35 °C). The experimental data consistently showed lower respiration at 35 °C as compared to what was predicted by the classical Arrhenius equation. To overcome this problem, a modified Arrhenius equation, incorporating the Boltzmann distribution function, was successfully introduced to account for this observed temperature effect, predicting a maximal respiration rate at 33.9 °C. The parameters of the final model were estimated with high precision, explaining 98 % the data variance. Additionally, it was shown that CO_2 had an uncompetitive inhibition on oxidative respiration, while O_2 concentration affected both oxidative respiration and fermentation. This is the first documented example of postharvest fruit respiration not following the classical Arrhenius' law at what could still be considered near field temperatures.