Title Modelling the gas exchange rate in perforation-mediated modified atmosphere packaging: Effect of the external air movement and tube dimensions

Author Julio C. Montanez, Fernanda A.S. Rodríguez, Pramod V. Mahajan and Jesús M. Frías

Citation Journal of Food Engineering, Volume 97, Issue 1, March 2010, Pages 79-86

Keywords Modified atmosphere packaging; Gas exchange rate; Turbulence

Abstract

Perforation-mediated modified atmosphere packages control the gas exchange rate and thus the internal atmosphere composition by judicious choice of dimensions of small tubes in perforations in an otherwise hermetic container. The aims of this work were (i) to study the effect of external turbulence on the gas exchange rate through small perforations, (ii) to develop a mathematical model to predict the effect of tube dimensions and hydrodynamic conditions on gas exchange coefficients, and (iii) validate the model developed during the storage of shredded carrots. Different hydrodynamic conditions in the controlled temperature room due to the storage temperature settings (5, 10 and 15 °C) and PVC tubes dimensions (diameter from 1.5 to 4.5 mm length from 2.0 to 6.0 mm) were tested. Results showed that, as expected, hydrodynamic conditions (induced turbulence) and tube diameter had a significantly positive effect on the mass transfer values, whereas tube length had a negative effect. The permeability ratio between CO_2 and O_2 was 0.83 ± 0.01 and did not show any pattern with the factors tested. The gas exchange coefficients increased with decreasing temperature, as the establishment of lower temperatures implied a frequent air movement. A mathematical model to estimate changes of gas composition over time as a function of tube dimensions and hydrodynamic conditions was developed and found to have good predictive abilities. The model was validated during the storage of shredded carrots at 5 °C in PM-MAP, showing a good agreement between the experimental and predicted gas exchange of O_2 and CO_2. The results obtained in this work showed that hydrodynamic conditions of the cold storage room affected the gas exchange rate in PM-MAP.