

ABSTRACT

The present work was conducted to develop mathematical model that can be utilised to design ethanol vapour controlled release active packages for fresh peeled shallot. The model active package was a solid plastic tray covered with the plastic film lid containing shallot and an ethanol vapour controlled sachet. The sachet was made of either Low Density Polyethylene (LDPE) or Nylon/PE film on one side and aluminium foil on the other, allowing ethanol vapour to release out from the sachet through LDPE or Nylon/PE film. The sachet contains 1g silica gel as carrier pre-loaded with ethanol. The active packages developed were kept at both 10 and 25°C for 10 days. Experimental results showed that ethanol vapour released to- and accumulated in the package had significant antimicrobial effects and could maintain qualities of fresh peeled shallot throughout the storage trials. The mathematical model was developed through conceptualising key mass transfer processes involved ethanol in the active packages given assumptions made to describe and to simplify changes in the sachet, package headspace, plastic film lid and fresh peeled shallot with respect to ethanol vapour. Experiments were undertaken to essentially quantify key model inputs including ethanol vapour sorption isotherm of silica gel, film permeability to ethanol vapour, and interaction rates between ethanol vapour and shallots. The mathematical model together with its inputs identified could reasonably predict trends in changes of ethanol mass left on carriers and of ethanol vapour accumulated in the package headspace. A lack of fit between model predicted and empirical results was noticeable, and principally this could be explained by sorption isotherm shape and assumption made on ethanol vapour-shallot interactions. The latter was influenced by possible physiological changes of shallot exposed to ethanol vapour over a long period. The mathematical model was utilised to simulate ‘what-if’ results of changes in model inputs which were considered key packaging design factors. The model gave reasonable simulation results that the packaging technical designers can be adopted as the preliminary data to consider advantages and limitations of the newly designed packages. Overall the model active packages developed are considered optimal active packages which have commercial potentials to keep fresh peeled shallot for 10 days. The mathematical model developed can be used as a mechanistic tool to facilitate technical designs of ethanol vapour controlled release active packages for fresh peeled shallots. It also has potentials to extend its capability for designs of other volatile controlled release active packages and other horticultural products.

Keywords: active packaging, mathematical model, packaging design, ethanol vapour