Title Parameter uncertainties and error propagation in modified atmosphere packaging modelling

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Abstract

Mathematical models are instrumental tools to predict gas (O_2 and CO_2) evolution in headspaces of modified atmosphere packaging (MAP). Such models simplify the package design steps as they allow engineers to estimate the optimal values of packaging permeability for maintaining the quality and safety of the packed food. However, these models typically require specifying several input parameter values (such as maximal respiration rates) that are obtained from experimental data and are characterized by high uncertainties due to biological variation. Although treating and modelling this uncertainty is essential to ensure the robustness of designed MAPs, this subject has seldom been considered in the literature. In this work, we describe an optimisation system based on a MAP mathematical model that determines optimal permeabilities of packaging, given certain food parameters. To integrate uncertainties in the model while keeping the optimisation computational burden relatively low, we propose to use an approach based on interval analysis rather than the more classical probabilistic approach. The approach has two advantages: it makes a minimal amount of unverified assumption concerning uncertainties, and it requires only a few evaluations of the model. The results of these uncertainty studies are optimal values of permeabilities described by fuzzy sets. This approach was conducted on three case studies: chicory, mushrooms and blueberry. Sensitivity analysis on input parameters in the model MAP was also performed in order to point out that parameter influences are dependent on the considered fruit or vegetable. A comparison of the interval analysis methodology with the probabilistic one (known as Monte Carlo) was then performed and discussed.