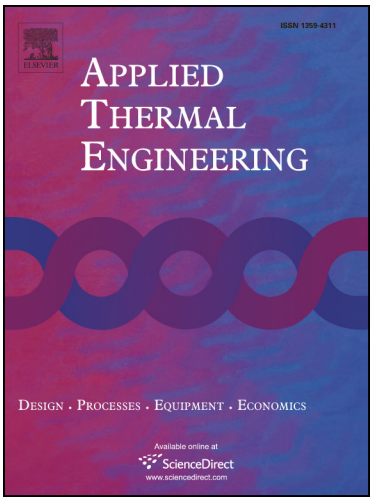

Research Paper

Insights in convective drying of fruit by coupled modeling of fruit drying, deformation, quality evolution and convective exchange with the airflow

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Insights in convective drying of fruit by coupled modeling of fruit drying, deformation, quality evolution and convective exchange with the airflow

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Abstract

Coupled modeling of fruit drying, deformation and quality evolution of a half-circular apple fruit slice is combined with modeling of the convective heat and mass exchange with the airflow. The aim was to gain more insight in the fruit drying kinetics, more particular in heterogeneities and couplings in moisture content and shrinkage as well as quality loss within the fruit during drying. Further aims were to investigate the impact of several modeling assumptions and to analyze the effect of the peel on the drying behavior. Large differences in internal moisture distribution and deformation were observed within the fruit slice. They were caused by the complex airflow field around the slice, which induced a spatial variation in convective heat/mass transfer coefficients (CTCs) over the fruit surface. The differences with imposing a single, constant CTC across the fruit surface (non-conjugate approach) indicated the need for including spatially-resolved CTCs (conjugate approach). The impact of including deformation in the model was also quantified. Not accounting for explicit airflow modeling or deformation affected the fruit temperature, and thereby also the fruit quality decay. The presence of a peel affected the drying process and the deformation, resulting in an asymmetrical collapse towards the center of the fruit slice. Coupling the modeled hygrothermal history of the fruit during drying, to fruit quality modeling opens new opportunities for optimizing drying processes. Thereby, the process can be optimized not only in terms of drying time or energy consumption, but also to achieve the best product quality.

Keywords: conjugate; apple fruit; convection; computational fluid dynamics; multiphysics