Title Finite element analysis of the dynamic collision of apple fruit

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Abstract

Possible sources of modelling error in discrete element method simulations of postharvest bulk processes are discussed. Finite element models are used to analyse the dynamic process of the collision of apple fruit amongst each other or with rigid walls. The major objective was to use these models to investigate the collision of apples in conditions that closely resemble typical practical collision regimes of such fruit during unit operations such as transportation in trucks, sorting operations or any other handling operations. Specifically, information on the quantity of energy loss that can be attributed to the excitation of elastic waves within the body was assessed in isolation to energy dissipation due to the viscoelastic nature of the material. Viscous dissipation effects of the fruit collisions are also studied. In particular, an assessment of two different methods of determining the effective viscous coefficient for a collision involving two viscoelastic objects (namely, the sum of inverses method and the arithmetic mean method) is carried out. For soft and relatively large objects such as the apple, the absorption of dynamic waves excited during collisions can lead to substantial kinetic energy losses. Amount of energy loss is dependent on the elastic properties of the material, the geometrical size of the colliding objects as well as the collision velocity. The currently available techniques for obtaining the viscoelastic properties of fruit using the stress relaxation experiments are not suitable for providing the characterization needed to describe the very short term processes such as collisions. The arithmetic mean method advocated by some researchers to determine the effective viscous coefficient during the collision of objects of different viscous properties is not appropriate. A more theoretically accurate assessment of the problem is necessary.