A multiscale coarse grained model for simulating mechanical responses of plant food tissues

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Abstract

Plant food materials are highly sensitive to the external mechanical responses. Simulation of the material behaviour under mechanical loading is important in many engineering applications. Several researchers have used tissue based (macroscale) and cellular based (microscale) numerical models to assess the plant material behaviour. In doing so, generally, finite element modelling and meshfree based discretization strategies are commonly used and the latter has been proven to be more flexible, accurate and more robust in numerical simulations. This study aims to develop a coarse grained (CG) model for a cellular system of plant food tissue in microscale. The basic idea here is to maintain the accuracy given by the cellular scale while minimizing the computational cost for the simulations. The developed model accounts for the deformation of a coarse grained system under an external mechanical load. In order to represent the viscoelastic behaviour of a plant food material, we use a spring-damper system connected to coarse grained beads. The model predictions show a satisfactory agreement with the morphological changes given by the cellular model. This developed CG model has laid a solid foundation for the further development of the multiscale model for the plant food tissue.

Keywords: plant food material, multiscale modelling, coarse grained model, spring and damper, cellular scale, computational cost