Application of caputo fractional rheological model to determine the viscoelastic and mechanical properties of fruit and vegetables

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Abstract

Determination of accurate viscoelastic and mechanical properties of fruit and vegetables (FV) is essential not only for designing appropriate equipment for harvesting, transporting, sorting and storing but also to determine the most appropriate process parameters in any food processing operation. Traditionally, classical models are used to determine these properties, which require many parameters and therefore deemed complex and computationally expensive. Moreover, many of these properties are not available in the literature. In this research, a comprehensive experimental investigation has been carried out to determine some rheological and mechanical properties such as relaxation modulus, apparent modulus, Poisson's ratio and Lame's coefficient of eight different fruit and vegetables using both classical and fractional viscoelastic models. The Caputo Fractional Rheological Model was found to be the better model than the classical models for determining viscoelastic properties as the single element fractional model was found to be sufficient to predict the viscoelastic properties with fewer parameters compared with the three elements classical model. A database of the mechanical properties of different fruit and vegetables have been presented. A relationship between the viscoelastic properties and the porosity has been established. It was also found that the Poisson's ratio of the fruit and vegetables widely varied with changing loading rates.