

Improved prediction of litchi impact characteristics with an energy dissipation model

Shuangming Zhang, Weizu Wang, Yanfei Wang, Han Fu and Zhou Yang

Postharvest Biology and Technology; Volume 176, June 2021, 111508

Abstract

A model of elastic impact (EI) and a model that considers energy dissipation (CED model) were developed to describe the deformation behavior during litchi impact. In the CED model, dissipation energy is due to damping effect and the change of elastic modulus after impact. Drop tests of fruit onto a fixed plate were conducted with a pendulum device for three litchi cultivars ('Nuomci', 'Guiwei', and 'Lvhebao') to test the accuracy of the two models. The results show that the CED model better simulated the change of fruit velocity during impact and better predicted the occurrence time of maximum impact force and maximum deformation compared to the EI model. Both models accurately predicted the maximum impact force of 'Guiwei' litchi with all errors less than 5 %, but had errors up to 24.8 % for the prediction of the maximum impact force of 'Nuomici' and 'Lvhebao' litchis at high drop heights (drop height ≥ 400 mm). The CED model accurately predicted maximum deformation (errors less than 8 %) but the EI model over-predicted maximum deformation with errors range from 12.2 % to 39.2 % at all drop heights for the three tested cultivars. Both models predicted the contact time with low-level errors (<10 %). With a reliable theoretical model, the impact characteristics of litchis can be calculated and then applied to assess the fruit damage degree.