Mathematical modelling of palm nut cracking based on Hertz's theory

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A mathematical model based on Hertz's theory of contact stress was developed for the prediction of force required to break the palm nut. Using nuts subjected to a uniaxial compression stress, in their lateral axis between rigid parallel plates, and those propelled to impinge a rigid cylindrical seat along its lateral axis, experimental verification of the model was conducted comparing the theoretical predictions with estimates from the representations of conventional methods employed in nut cracking. Properties including size, shape and mass, required in the derived model were determined for two varieties of the palm nut. Material stiffness was obtained from the force–deformation curve.

Regression analysis showed an exponential variation of the cracking force with nut deformation. Material stiffness obtained was 654 N/mm and 303 N/mm for the 'Dura' and 'Tenera' nuts, respectively. The respective ranges of geometric mean diameters were 17·07–27·68 mm and 22·32–26.51 mm. There was no significant variation of nut sphericity with size or variety.

Force prediction from the Hertzian model proposed gave good prediction of cracking force that was not significantly different from that obtained from a centrifugal nutcracker driven at 1500 min^{-1}, with a 40 cm diameter cracking chamber

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