Title Design and testing of a mangosteen fruit sizing machine

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Citation Journal of Food Engineering, Volume 79, Issue 3, April 2007, Pages 745-751

Keywords Mangosteen; Sizing

Abstract

This research concerns the development of a rotating disk mangosteen sizing machine for fruit growers and small entrepreneurs. The methodology comprised design, construction, testing, and engineering and economic evaluation of a laboratory prototype machine. The basis of design is characterized by a rotating conical-shape disk and a metering board with gaps of increasing size arranged along the periphery of the disk. Mangosteens are fed onto one section of the rotating disk and the combined centrifugal and gravitational force moves the fruit toward the periphery until contact with the metering board is attained. The tangential force then rolls the fruit along the metering board, where they are sized and allowed to drop through gaps according to their dimensions. Design parameters included disk diameter, disk speed and type of metering gap. Testing of the laboratory prototype was statistically factorial in completely randomized design, featuring two control factors (namely, metering gap type and disk speed) and three performance evaluation parameters: mean contamination ratio (C_R) , sizing efficiency (E_w), and throughput capacity (Q). Results showed that the rotating disk speed and metering gap type significantly affected ,C_R E_w, and Q at 5% significance level. The most efficient configuration was a rotating disk speed of 21 rpm using a step-type metering gap, resulting in C_R = 14.7%, E_w = 84.7% and Q = 1076.6 kg/h. A factory prototype of the same scale was developed with reference to the optimum design parameters of the laboratory model. The factory model, which contained a 400 mm feed opening and a 600 mm diameter disk, was tested with 650 kg, mixed size, newly harvested mangosteens. Performance testing of the factory prototype showed that minimal fruit damage (0.48%) occurred at C_R = 22.8% and Q = 1026 kg/h. The machine under review showed better performance than currently existing commercial models and the sized mangosteens were well accepted by fruit wholesalers. An engineering economic analysis showed that the break even point and pay back period for the factory model would be 46,020 kg/yr and months, respectively.