ABSTRACT

DESIGN AND DEVELOPMENT OF COCONUT GRADER

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Coconut is one of the important horticultural crops and the most valuable gift to mankind. According to Coconut Development Board, India has earned around Rs. 7234 lakh in the year 2013-14 from the export of fresh coconuts. It gains its importance as it provides food, oil, beverage, medicine and raw material for the variety of industrial productions. In India more than 10 million people depend on the coconut for their livelihood and the major contribution is from the small and marginal farmers.

There are many intermediaries between the producers and the consumers in marketing of coconut, as a result farmer's benefit less while consumers pay more. Moreover farmers sell their produce without grading. According to the observations, proper grading facilities are lacking, which required for the effective marketing of coconut. This is mainly due to the nonavailability of machineries required for grading the coconuts. Therefore, present research concerns the development of dehusked coconut grading machine for coconut growers and entrepreneurs.

In order to design and fabricate the size and weight grader for dehusked coconut, selected physical properties such as length, width, thickness, geometric mean diameter, sphericity, surface area, bulk density and true density were determined. Compositional changes in coconut fruits, including volume and weight, shell weight, weight of mature coconut water, weight of fresh kernel, weight of copra, thickness of the flesh and shell, were also evaluated. The average fruit length, major diameter and minor diameter were 99.2±13.3, 91.5±8.9, and 89.5±8.7 mm, respectively; while the sphericity, true density, bulk density and surface area were 0.90±0.05, 998±68.8 (kg/m^3), 483±37.3 (kg/m^3) and 274.2±50.4 (cm^2), respectively. Fruits ranged widely in weight exhibiting 4.1-fold increase between the smallest and largest fruits. The weight of kernel, shell and copra were in the range of 110-348 g, 64-173 g and 62-201 g, respectively. The mean thickness of shell and kernel were 3.79 and 11.67mm, respectively. The percentage weight of kernel, copra and shell to total weight of nut were 53, 29.8 and 28.25 per cent, respectively. The average value of coefficient of friction for the dehusked coconut on different surfaces namely, card board, rubber, stainless steel, aluminium and galvanised iron were 0.272, 0.43, 0.318, 0.256 and 0.388, respectively.

Correlations between fruit characteristics were also determined. It was observed that the measured variables were mostly correlated each other. To achieve the least possible number of components which governs original variation in the dehusked coconut principal component analysis was performed. From the PCA results, two plots *viz.*, score plot and loading plot were obtained for three different sizes, range of dehusked coconut (80-90, 91-100 and 101-110 mm diameter). The result of loading plot revealed that, the weight of nut and weight of kernel was the chief important variables in all the ranges of sizes of dehusked coconut. To find the variation between the weight of nut in each range of size of dehusked coconuts score plot was helpful.

The basis of size grader were characterized by a tapered belt conveyor and sizing board with openings of increasing aperture arranged along the periphery of the belt conveyor. Dehusked coconuts were fed onto the tapered belt conveyor where the gravitational force moves the fruit towards the periphery until it comes in contact with sizing board. Due to the tangential force, the fruit reels along the sizing board, where they sized and allowed to drop through aperture according to their dimensions. The size grader

was tested for its overall performance, by operating at five different velocity of 1.3, 1.5, 1.7, 1.9 and 2.1 m/s, three different inclination angle of 10, 15 and 20 degree for both semi and fully husked coconuts. Performance tests indicated that the velocity and inclination angle of the belt significantly affected the contamination ratio, grading efficiency and throughput capacity at 5% significant level. The most efficient configuration for fully husked coconut and semi husked was a velocity of 1.3 m/s with the inclination angle of 15^{o} and velocity of 1.5 m/s with the inclination angle of 15^{o}, respectively.

The electronic weight grading machine was developed based on the four bar linkage mechanism, for dehusked coconut. The prototype consist of feed hopper, electronic weighing assembly, proximity sensor, pneumatic actuators, direction control valve and drive transmission. The developed machine is capable of metering coconut to weighing section and weighing of individual coconut and grading them into three different weight grades. The developed weight grader was tested for its overall performance, by operating at three different angular velocity of 12, 14 and 16 rad/min and settling time of 2, 3 and 4 s. The performance test indicated that the angular velocity and settling time significantly affected the grading efficiency and contamination ratio at 1 % significant level. The developed weight grader was most efficient at the angular velocity of 16 rad/min and settling time of 4 s.

The developed coconut graders are found to be reliable and will be much useful in grading the coconut.