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CONCEPTUAL DESIGN OF A SAGO DRYING MACHINE AND STRUCTURAL SIMULATION USING FINITE ELEMENT ANALYSIS

SHAHROL MOHAMADDAN*, LEW HAO XIAN, MOHD FADZLI ASHARI, MARINI SAWAWI AND MOHAMAD SYAZWAN ZAFWAN MOHAMAD SUFFIAN

Department of Mechanical and Manufacturing, Faculty of Engineering, Universiti Malaysia Sarawak, Kota Samarahan, Sarawak, Malaysia.

**Corresponding author: mshahrol@unimas.my*

Abstract: The increasing demand for sago flour indicates the need to enhance its production. The objective of this research is to propose a new design of a sago drying machine and conduct a finite element analysis (FEA) simulation on its structure. The sago drying machine was developed based on a tray-mixer concept. Mathematical modelling and simulation analysis were conducted on three critical parts; the tray, support plate and mixer. The maximum stress for the tray bending was 6.51 MPa with manual calculation and 7.37 MPa with simulation analysis. The tray-bending deflection was 0.52 mm with manual calculation and 0.53 mm with simulation analysis. For support plate bending, the maximum stress was 17.33 MPa with manual calculation and 12.87 MPa with simulation analysis. The deflection for support plate bending was 1.06 mm with manual calculation and 1.04 mm with simulation analysis. Lastly, the maximum stress acting on the mixer was 1.09 MPa and maximum deflection was 0.0035 mm. The error between mathematical calculation and FEA simulation was based on different assumptions on the model and limitation of dimensions covered, for example, the 2D and 3D views. Data from this research could be used to improve the structural design of a new sago drying machine.

Keywords: Sago, drying machine, conceptual design, FEA simulation, structural analysis.

Introduction

Sago is a starch extracted from the pith of the sago palm (*Metoxylon sagu*). The name of the genus *Metroxylon* is a combination of two Greek words, meaning heart wood, which describes the large proportion of pith contained in the trunk of the palm. Sago is a staple in the lowlands of New Guinea and Moluccas islands (Vijay *et al*., 2017). In Malaysia, it is an inexpensive and reliable source of starch although it is not a staple food (Kamal *et al*., 2007). The plant is grown as a crop by natives in Sarawak and because of its high starch content, it has been dubbed the "starch crop of the 21st century" (Kamal *et al.*, 2017). One palm tree can yield around 150 to 300 kg of sago (Lal, 2003).

The sago planted in Sarawak is called *Rumbia* and the harvest period depends on soil fertility. On average, it may be harvested for between 12 and 13 years if grown in normal soil, but when planted in peat soil, it may be extended to between 15 and 18 years. Sago is harvested shortly before or early in the palm tree's flowering stage, when starch content is highest. The trunk is cut into sections and the pith is extracted and pulverised, before water is used to wash out the starch kernels. Sago starch can be used to make biscuits (tebaloi), cakes, noodles and crackers.

Traditionally, the freshly extracted starch kernels is dried under the sun or on wood-fired stoves for large quantities of harvest (Pendita *et al*., 2014). However, the use of wood-fired stoves is not efficient and contributes highly to greenhouse gas emission, which is the cause of global warming. Besides the sun and wood-fired stoves, sago can also be dried using hot air and solar hybrid methods.

Sun-drying alone is time consuming and subject to weather, where rain and cloud may disrupt the process. A hybrid dryer combines the use of solar and electrical energy to dry the