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DEVELOPMENT AND EVALUATION OF A JATROPHA FRUIT HUSKING MACHINE

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ABSTRACT

The *Jatropha Curcus* L has emerged on the world energy race as a promising plant for the production of biodiesel. However, this crop still lacks the development of specialized machine for post-production. The objective of this research work was to design, develop and evaluate small scale Jatropha fruits husking machine for bio-fuel production. Engineering properties for Jatropha fruits before husking and after husking have been successfully studied and evaluated. The Jatropha fruit before husking had an average geometric mean diameter, sphericity, crushing force, length, width, and thickness of 21.80 ± 0.03 mm, 0.84 ± 0.06%, 79 N.m, 26.49 ± 8.07 mm, 21.088 ± 4.92 mm and 19.280 ± 4.68, respectively. While, Jatropha fruit after husking (seeds) had average length, width, and thickness of 24.49 ± 8.07 mm, 19.088 ± 4.92 mm, and 17.28 ± 4.68 mm, respectively. The developed husking machine consists of frame, feed hopper, fruit husking chamber, concave sieve, rotating blades, discharge outlet and a vibrating separator equipped with a sieve for the separation of seeds and husks. The machine was powered with a 0.5 hp AC motor, and had overall dimensions of 1250 mm length, 1100 mm height, and 500 mm width. The obtained results showed that the mean values of the cleaning efficiency, husking capacity, husks percentage and whole seeds percentage were 91.78 ± 1.97%, 44.058 ± 2.79 kg h^{-1}, 34.24 ± 0.94% and 61.99 ± 3.52%, respectively. The husking machine total cost was estimated at 600 US Dollars.

Keywords: biofuel, jatropha fruit, engineering properties, husking machine, post-harvesting.

INTRODUCTION

Introducing biofuels; which referred to any fuel obtained from organic material in solid, liquid or gaseous form (Dragone *et al*., 2010); around the world as alternatives of finite fossil fuels is of massive growth, because they are characterized as the most valuable forms of renewable and sustainable fuels. Biofuels; which are considered to be environmentally friendly and of low carbon emission compared to the traditional fossil fuels of finite availability and high impact on the environment, can play an important role in the future energy supply (Alam *et al*., 2012; Nigam and Singh, 2011; Zhuang *et al*., 2010).

As reported by HELPE (2013), production of biofuels around the world has increased five times in less than 10 years, i.e. from less than 20 billion liters/year in 2001 to over 100 billion liters/year in 2011. Hence, biofuel production strategies should take into consideration food security aspects, so that biofuels can be safely produced where it is feasible from social, economical and environmental points of view. Therefore, utilizing non-food biomass raw materials, such as Jatropha curcas; can help to achieve sustainable production of cost-effective biodiesel with less emission, through the successful use of advanced biofuels technologies (Abdelrahim *et al.*, 2013)? Biodiesel produced by the transesterification of plant oil extracted from Jatropha fruits is classified within the first generation of secondary biofuels (Nigam and Singh, 2011).

Jatropha curcas L. is a drought resistant variety which develops well under a broad range of arid and semi-arid climates, and is characterized as either small shrub or large tree of up to five meters high with a lifespan of more than 50 years (Kumar and Sharma, 2005). It belongs to the family euphorbia and its origin is Mexico and Central America; then transferred to Africa and Asia, and currently it is cultivated worldwide especially under tropical and sub-tropical conditions (Warra, 2012; Brittaine.and Lutaladio, 2010; Sotolongo *et al*., 2007). Jatropha can start producing fruits from the age of six months and attains yield stability after 1-3 years age (Pradhan *et al*., 2009a). Jatropha seeds look like castor in shape, black in colour and are 42% husk and 58% kernel (Agbogidi *et al*., 2012). Also as reported by Singh *et al*. (2008), a fresh harvested and dried Jatropha fruit comprises a weight of 35-40% shell and 60-65% seed; while, the seed contains 40-42% husk/hull and 58-60% kernels. Depending on the growing season and conditions and the availability of water and nutrients, the yield of Jatropha is ranging from 0.1 to 12.0 t ha^{-1} (Openshaw, 2000; Achten *et al*., 2008, Agbogidi *et al*., 2012). Previous studies reported high oil content of Jatropha seed. As examples: 66.4% (Adebowale and Adedire, 2006), 50% (Raja *et al*., 2011), 37.4% of the whole seed and 46.0-48.6% of the kernel (Kandpal and Madan, 1995), and 45.03% of the kernel (Pradhan *et al.*, 2009b), 27-40% of the seeds (Agbogidi *et al*., 2012).

The processes of husking and shelling Jatropha fruits are of great importance for the process of extracting Jatropha oil in terms of both oil quantity and quality. These two processes can be performed either manually or by using specialized mechanical systems (Achten *et al*., 2008; Lim *et al.*, 2014). The manual or traditional methods (using hand tools and fingers) are tedious, time consuming and labor intensive processes, in addition of causing serious harm to the fingers of the workers as well as the low output rates, which was estimated at a maximum of 50 kg of dried fruits per worker (Pradhan *et al.*, 2010; Lim *et al*., 2014). Hence, the replacement of traditional methods