



# Development of a User-friendly Tool for Pulp Separation from Palmyrah Palm Fruit


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## ABSTRACT

The study was conducted to develop a user-friendly tool for the separation of pulp from toddy palm fruit under the Department of Processing and Food Engineering, KCAET Tavanur during 2019–20. Manual separation of pulp using traditional method is very time consuming, tedious, labour intensive and cause drudgery to the operator. Hence, a skilled person can only separate the pulp from palm fruit perfectly. Therefore, a simple hand operated tool for separating pulp effectively which is easy to operate, portable, gender friendly and economical was designed and fabricated. Based on engineering properties, a cutting tool and U-shaped cutting blade were developed. The palm was removed from the bunch and crown was removed using a knife. Then the fruit was placed horizontally on “M” shaped holding unit. Using the cutting knife, the bottom portion of palm was cut up to 5cm thickness and top portion up to 2.5 cm. Then the fruit was placed vertically on the rectangular platform and the “U” shaped blade was inserted into the fruit on the outer periphery. Blade is then pushed side ways to remove the husk of the palm fruit. The performance evaluation of the developed tool was conducted. The performance evaluation of the developed tool was done in terms of capacity and material loss. The average capacity of the tool was found to be 9.01 kg h<sup>-1</sup> which accounts pulp of 45–50 fruits h<sup>-1</sup>. The material loss during the operation was estimated to be 2.4%.

**KEYWORDS:** Cutting blade, palm fruit, pulp and seed separating tool

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**Data Availability Statement:** Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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## 1. INTRODUCTION

Palmyrah palm (*Borassus flabellifer*) belongs to the kingdom Plantae, order Arecales and family *Areaceae*. Palmyrah palm is also known as toddy palm, doub palm, tala palm or wine palm (Graupner et al., 2019). The palm produces fruits when 15–20 years old, giving an annual crop of 50–200 fruits in 6–12 bunches per tree (Vengaiah et al., 2015). It is a tall and erect palm, with large, fan-shaped leaves which are quite unlike the pinnate leaves of other palms. It is a dioecious palm with the great majority of its economic products, such as immature endosperm, mesocarp pulp, fibre from the fruits and tuberous seedlings, obtained only from female palms. The immature soft juicy seed nuts (pulp) and neera (sap) are very popular in the tropical parts of India as a soft natural drink to protect against hot summer (Chaurasiya et al., 2014., Dennis and Johnson, 1987). The multifaceted uses (~800 uses) of the tree as food, wood and medicine make it a viable industrial crop (Siju and Sabu, 2020). It is the official tree of Tamil Nadu state of India (Jerry, 2018) and is abundantly grown in the eastern parts of Kerala especially at Palakkad district.

Fresh pulp is reportedly rich in vitamins A and C (Sandhya et al., 2010). The whole fruit of the Palmyrah palm contains about 40% of undiluted pulp which is white in colour with its characteristic flavour (Vengaiah et al., 2017). Traditionally, the fruit is used to treat digestive issues and stomach ailments because of its nutritional value (Vengaiah et al., 2015., Madhuri and Raizaday, 2021). The fruit pulp of *Borassus flabellifer* (Asian Palmyrah palm) has been used in traditional dishes and the sap, has been used as a sweetener for diabetic patients (Gummadi et al., 2016). Moreover, the other parts of the plant such as root, leaves and trunk are used for various purposes. Usually, a single tree will bear anywhere between 50 to 300 fruits. The size of the fruits ranges from 4–8 inches diameter, and are black, greenish and white in colour (Muthuvelammai, 2017). For centuries, the Palmyrah palm has been tapped in order to produce fresh juice (sweet toddy), fermented drinks (toddy, wine, and arak), syrup (honey), brown sugar (jaggery) or refined sugar (Srivastava et al., 2017., Rajendran et al., 2008). This plant has a very close connection with the rural livelihood, cottage and agro-based industries of Indian economy (Krishnaveni et al., 2020). Tapping of Palmyrah toddy is the primary source of livelihood in eastern Palakkad. The top portion of the fruit must be removed to get the two or three sweet jelly seed sockets as shown in Figure 1 which is translucent pale-white in appearance. A thin yellowish-brown skin covers the jelly part of the fruit. The fleshy white body contains watery fluid inside. The final ready to eat form of palm fruit is shown in Figure 2.

The major problem related to the processing of Palmyrah

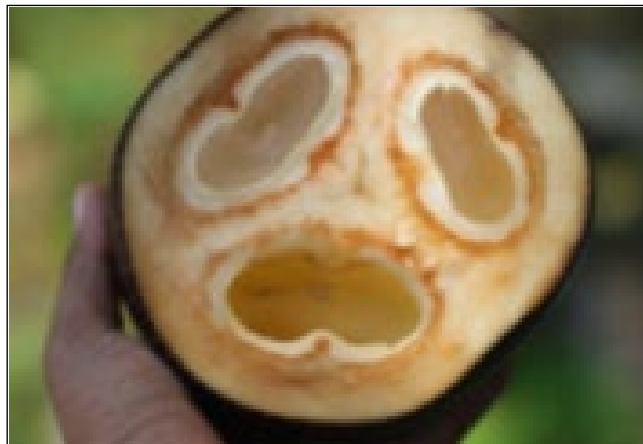


Figure 1: Palm fruit with seeds



Figure 2: Palm seeds ready to eat

palm fruit is the pulp separation. At present, the pulp separation is done manually using a knife. This traditional method of pulp separation is a tedious process usually done by skilled labour and is time consuming, labour intensive and cause drudgery. Hence mechanization is the need of the hour in this sector to separate the pulp safely without drudgery. Therefore, an attempt was made to develop a user-friendly tool for the separation of pulp from toddy palm fruit. The development of such a pulp separating tool will definitely help toddy palm farmers.

## 2. MATERIALS AND METHODS

The study was conducted under the department of Processing and Food Engineering during 2019–20. Before the fabrication of the machine, important physical and mechanical properties of palm fruit were studied. The physical parameters viz., diameter, thickness of husk, spacing between seeds and mechanical properties viz., cutting strength were measured using standard procedures. The palm fruits were procured from Palmyrah palm growers. Fruits were kept in a cool chamber at 8°C till the conduct of the experiment.

### 2.1. Development of the tool

Based on the engineering properties of Palmyrah palm fruit, a manually operated tool was developed. The tool consists of a Base plate, cutting knife, holding platforms and “U” shaped blade, The Auto CAD drawing of the developed tool is shown in Figure 3 and 4.



Figure 3: Toddy palm pulp separating tool

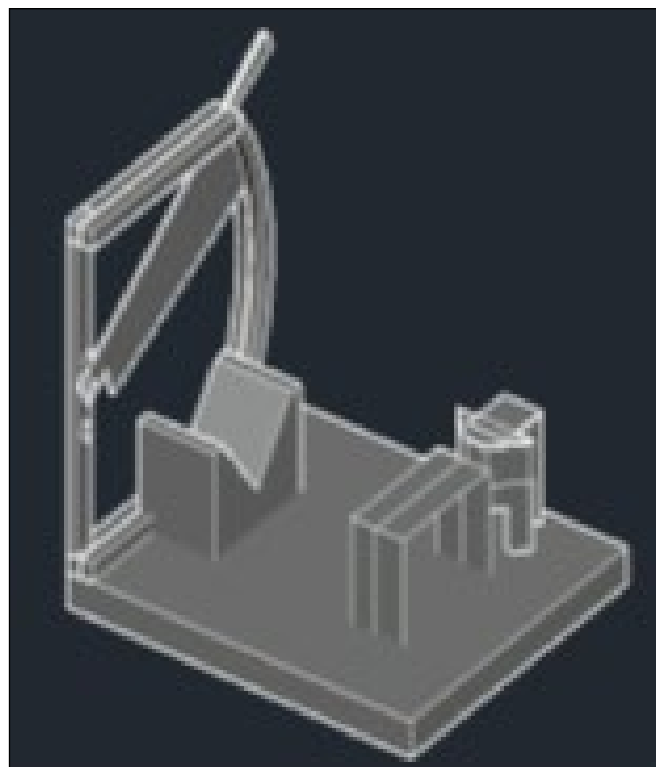


Figure 4: Auto CAD drawing of developed tool

#### 2.1.1. Base plate

The rectangular base consists of SS plate of AISI Type 302 SS. The other parts viz., cutting knife, holding platform and ‘U’ shaped blade were mounted on it.

#### 2.1.2. Cutting knife

A SS (AISI Type 302) knife of length 20 cm and width 9 cm was fitted in a frame work as shown in the Figure 5. This knife can be moved up and down to cut the top and bottom portion of the fruit.



Figure 5: Cutting knife

#### 2.1.3. Holding platforms

The tool consists of two holding platforms. A “M” shaped holding platform was made to seat the palm fruit during cutting operations, whereas a rectangular platform helped while pulp separation.

#### 2.1.4. U shaped blade

A ‘U’ shaped blade made of SS (AISI Type 302) was used to remove the pulp from fruit. Cutting edge has been sharpened using a file. The blade has a length of 120 mm and height of 60 mm. The two arms of the blade are inserted into the sides of the pulp from top of the fruit. Then the blade is pushed sideways and the pulp is removed from the husk (Figure 6).

### 2.2. Operational procedure

The Palmyrah fruit was procured from Palmyrah palm growers at Palakkad. The palm was removed from the bunch using a cutting knife and the crown was removed. Then the fruit was placed horizontally on “M” shaped holding unit.



Figure 6: U shaped blade

Using the cutting knife, the bottom portion of palm was cut up to 5 cm thickness. The same procedure was repeated to cut the top portion up to 2.5 cm. Then the fruit was placed vertically on the rectangular platform and the “U” shaped blade was inserted into the fruit on the sides of the pulp. Blade is then pushed side ways to remove the husk of the fruit. Repeat the same process for the removal of other pulp and clean the tool after operation. The performance of the tool was evaluated in terms of capacity and material loss using following formulas and compared with traditional operation.

$$\text{Capacity (kg hr}^{-1}\text{)} = (\text{Total weight of palm fruit} / \text{Time taken for separation}) \dots\dots\dots (1)$$

$$\text{Material Loss (\%)} = (\text{Weight of the pulp loss during separation} / \text{Total weight of the pulp}) \times 100 \dots\dots\dots (2)$$

**3. RESULTS AND DISCUSSION**

*3.1. Engineering properties of palmyrah palm fruit*

Engineering properties of agricultural produce are generally useful in designing and development of machineries in the field of farm machinery, food processing etc. Prior to the development of tool, engineering properties of palmyrah palm fruit viz. diameter, average spacing between pulp, thickness of outer husk, dimensions of fruit pulp and mechanical properties such as cutting force were studied. The engineering properties of Palmyrah palm fruits are shown in Table 1.

The diameter of the palm fruit was 99±8.94 mm with an outer husk thickness of 15.76±3.92 mm. The length, width and thickness of the pulp were found to be 62±4.95, 47±5.70 and 25.6±5.32 mm, respectively. The average spacing between the pulp was found to be 67±6.71 mm. A Universal

Table 1: Engineering properties of palm fruit

Properties	Value ±SD
Diameter (mm)	99±8.94
Average spacing between pulp (mm)	67±6.71
Thickness of outer husk (mm)	15.76±3.92
Pulp Thickness (mm)	25.6±5.32
Width (mm)	47±5.70
Length (mm)	62±4.95
Cutting force (kgf)	10±0.001

Testing Machine was used to measure the cutting force required to cut the palm fruit. The average cutting force of Palmyrah palm fruit was found to be 10 kgf.

*3.2. Performance evaluation of the developed tool*

Performance evaluation of the developed tool was conducted at farmers field in Palakkad district with 3 days interval. Evaluation was done in terms of capacity and material loss. The average time required to separate pulp from 50 tender palm fruit using traditional cutting knife was 8.5 minutes. Similarly, the average time required to separate pulp using the developed tool was 7.30 minutes. The average capacity of knife and developed tool were estimated to be 7.5 and 9.01 kg h<sup>-1</sup> respectively.

The performance of developed tool was evaluated in terms of material loss. The % material loss of developed tool was found to be 2.43 which is on par with traditional method.

**4. CONCLUSION**

A gender-friendly tool for the separation of pulp from palmyrah palm fruit was developed. The tool consists of base plate, cutting knife, holding platform and U shaped blade. The performance evaluation of the developed tool was done in terms of capacity and material loss. The capacity and material loss of developed tool was found to be 9.01 kg h<sup>-1</sup> and 2.4%, respectively. The cost of developed tool was found to be ₹ 6000/-.

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