

Exploring Resources, Process and Design for Sustainable Urban Development

Proceedings of the 5th International
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Surakarta, Indonesia • 12–13 December 2018

Editors • Anto Budi Listyawan, Nurul Hidayati,
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Coconut shell breaker machine

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Coconut Shell Breaker Machine

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Abstract. The coconut derivative industry continues to grow by diversifying the coconut processing industry. This is evident from the variety of post-harvest coconut processing both from food and non-food products. Especially for edible by-products based on coconut meat, they seemed to be prospective and have a high selling value, among others is the virgin coconut oil (VCO). VCO is a product of pure coconut oil that is beneficial for health, especially in increasing the body's immunity against various degenerative diseases, and can be used as raw materials for natural cosmetics with high economic value. The present study aims to produce a technology package for the processing of coconut fruit into VCO. As the initial stage of the VCO production is the process of breaking the coconut shell—which is the hardest part of a coconut fruit. Therefore, the shell breaker machine is developed in which it has several components, including: sprocket safety cover, capacitor, belt cover, electric motor as drive, switch on/off, coconut shell breaker sprocket, coconut shell breaker and breaker, gear box and screw adjuster. The capacity of the tool to break the coconut shell is 1 coconut per minute. The driver uses a 1:50 gear box and an AC motor $\frac{3}{4}$ hp. This coconut shell breaker is designed by considering ergonomic and safety aspects for users. The output obtained from this study is a coconut shell breakdown tool where coconut shell can be peeled off so that the coconut meat is still intact and the coconut water is not wasted because it can be used for the washing process in subsequent phase of this study.

INTRODUCTION

The dispersion of coconut plantations is evenly distributed throughout Indonesia, and specifically in the East Java region in which the distribution is 7.67% of the total coconut plantation in Indonesia. In the East Java region, coconut production has an area of 300 thousand ha and has reached its surplus, producing approximately 1.5 billion coconuts per year.^[1] If the price of a coconut is Rp. 3,000, the economic value of the total coconut production in East Java will reach approximately Rp. 4.5 trillion. Meanwhile, the consumption of coconut in East Java is around 30 coconuts per year per person, which if multiplied by the population of East Java (approximately 38 million), the result will be more than 1 billion coconuts per year. Therefore, there is a surplus of almost 500 million coconuts per year., which later are distributed to various regions in Indonesia while 77 thousand tons are also exported to various countries.

In fact, the demand for coconut-based products continues to increase both for at domestic market and global market. Various prospective industries from coconut derivatives can still be developed by diversifying the coconut processing industry both from food and non-food by-products. Among the by-products are oleo chemicals, desiccated coconut, virgin coconut oil, nata de coco, furniture, fiber, coir, activated charcoal, and so forth. In Indonesia, the development of coconut-based processing industries is initiated by the development of the dried coconut meat or called copra as a raw material for the coconut oil industry.

Despite of the increasing trend in coconut by-products, some problems in the processing industry are often found, among others in the aspects of raw materials, production and marketing. Another current issue is the high level of unproductive coconut plants (old and damaged), which reaches 30—40% of the community plantation area. Meanwhile, the limited supply of raw materials, both in terms of quantity and quality and also production, lead to many constraints, including the simple, conventional methods employed in the production centers for Small and Medium Enterprises for coconut processing, as well as the limited number of coconut processed products. Such conditions urge the need to accelerate the development of processed new products which market demand tends to increase (demand-driven business).

Several coconut by-products have global market prospects, especially the coconut meat derivatives that are increasingly popular and also have a high selling value. Among these by-products is Virgin Coconut Oil or VCO. VCO is a product of coconut fruit that can improve health, especially increasing the body's immunity to various degenerative diseases and as the raw material for natural cosmetics with a high economic value. VCO is pure coconut oil which fatty acid content is intact and has far less bonds to be damaged by the heat. As pure coconut oil, VCO contains various medium chain saturated fatty acids which one of its contents is 48% lauric acid and has the same function as breast milk, which causes the body to become immune to various diseases [3]. The largest amount of fatty acids in VCO is lauric acid, which is a saturated medium-chain fatty acid with 12 carbon without double bonds, and has the name IUPAC dodecanoic acid and has a molecular weight of 200 [2].

The economic potential of coconut has not been used optimally because of various internal problems both in the production, processing, marketing and institutional processes [3]. Efforts to empower human resources continue to be made, especially through the utilization of technology. Various methods of coconut processing technology to produce VCO are developed, including centrifugal, fermentation, enzymatic and pumping methods. Each method has advantages and disadvantages in terms of the yield and the quality of the VCO oil. In the present study, centrifugal technology will be applied due to its advantages, namely: the duration is relatively short, no chemical addition, free of contamination and the better quality yield compared to those generated from mechanical and fermentation methods. According to [4,5,6] This study aims to produce a technology package for the processing of coconut fruit into the virgin coconut oil (VCO). As the initial stage of the VCO production is the process of breaking the coconut shell—which is the hardest part of a coconut fruit.

RESEARCH METHODOLOGY

The design of the coconut shell breaker machine as the initial process of the VCO production is carried out through the stages as follows:

1. Identification of the needs of the home industry concerning with the current design of coconut shell breaker or tool along with the constraints/problems faced during the operation. It was aimed at extracting the information required in making the design and manufacture of the developed coconut shell breaker machine.
2. Design process by technically drawing the coconut shell breaker machine.
3. Identification of the materials for designing the machine.
4. Design tools as the realization of technical drawings that have been devised previously.
5. Supervision to several workshops for job monitoring.
6. Measurement and testing the tools to divulge the overall performance of the tool.

The road map for the first phase of the first year of research, which is designed for a period of three years in total, can be described in Fig. 1 below.

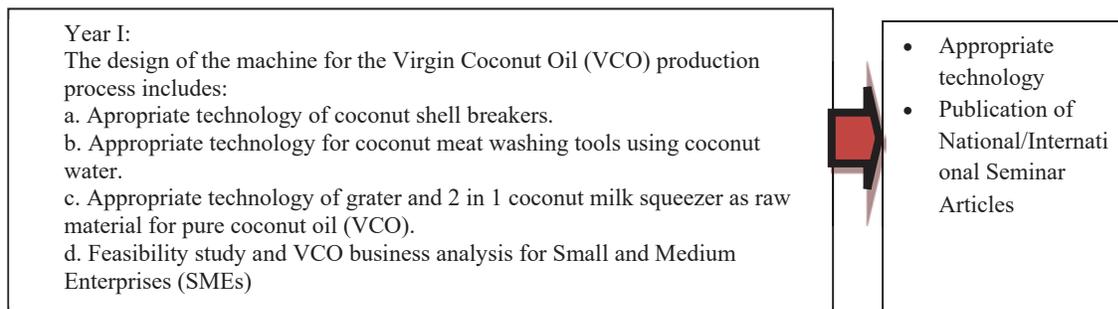


FIGURE 1. The first stage of research

THE DESIGN AND DEVELOPMENT OF COCONUT SHELL BREAKER

Coconut plants (*Cocos nucifera* L.) are considered as multipurpose plants because all their parts can be used to improve the human welfare. Essentially, the economic value of coconut is quite high because each part of the coconut plant, including coconut water, meat, leaves, stems, shells and coconut fiber can be utilized for human interest. The composition of coconuts is shown in Table 1.

TABLE 1. Composition of Coconut Fruit[7]

Fruit Meat (Old Coconut)	Amount of weight (%)	Benefits
Coconut coir	35	Fuel, seat covers, woven ropes, mats and planting media for orchids
Shell	12	Fuel, handicraft raw materials
Coconut fruit	28	Neutralizing toxins and providing a refreshing / sedative effect
Coconut water	25	Freshener drinks, nata de coco

In the stage of surveying the coconut fruit traders, the information needed to make the design and manufacture of coconut shell breakers was gathered. It involves the identification of the needs of coconut home industry, particularly how to break down the coconut shell as they have been doing so far. The constraints and problems faced by the SMEs in the process of breaking coconut shells can be shown in Table 2.

In general, coconut fruit home industry and sellers still use very simple, traditional tools to break down the coconut shell. The common tool is a crowbar, which is used by hitting it into the coconut shell until breaking down. Even though they have to peel more than 100 coconuts per day, the actors of coconut processing and sellers have to sit, stand and slightly bend their body during the process of breaking the coconut shell. This activity can potentially cause complaints or aches in the joints on the back, neck and waist. In addition the palms of the hands used to hold the coconut and the legs used to hold the body often feels pain. The lack of safety also causes the possibility of accidents during the process of breaking coconut shells, which is also very susceptible, due to the use of a sharp crowbar in unprotected conditions without using any gloves or tool cover.

Table 2. Constraints faced during the coconut processing and the needs of coconut SMEs

NO	Constraints faced by coconut small coconut traders	The need of coconut SMEs
1	Coconut shells break into small parts, and must gouge coconut meat to release it from the shell.	Can break the coconut shell and release coconut meat in one process without scouring
2	Long and inconsistent solving time.	A practical solver and can work continuously
3	The process of removing shells from coconuts fruit is difficult.	Ease in the process of removing shell from coconut fruit
4	Complaints of pain in the back, neck, waist.	Coconut shell breakers can reduce workload and fatigue levels of users.
5	Coconut shell breakers can reduce workload and fatigue levels of users.	Do not use high power, save energy
6	Possible work accidents when solving and releasing shells from coconut fruit	Prevent work accidents
7	Coconut shell breaker can be used to break the shell and release it from coconut fruit every day (continuous)	Coconut fiber peeler is made strong and durable

This coconut shell breaker is in the form of a box consisting of a breaking gear, a coconut clamp that can be adjusted according to the size of the coconut. The working principle of this tool is the incorporation of the clamping, pressing and shifting processes according to the coconut fiber cutting path. The drive of the coconut shell breaker blade is driven by an electric motor which rotation has been reduced to produce a large torque. Coconut shells are the hardest part of a coconut fruit. Therefore this shell breaker has several parts, including: sprocket safety cover, capacitor, belt cover, electric motor as drive, switch on/off, coconut shell breaker sprocket, coconut shell breaker and breaker, gear box and screw adjuster. The components of the coconut shell breaker can be shown in Fig 2 and 3.

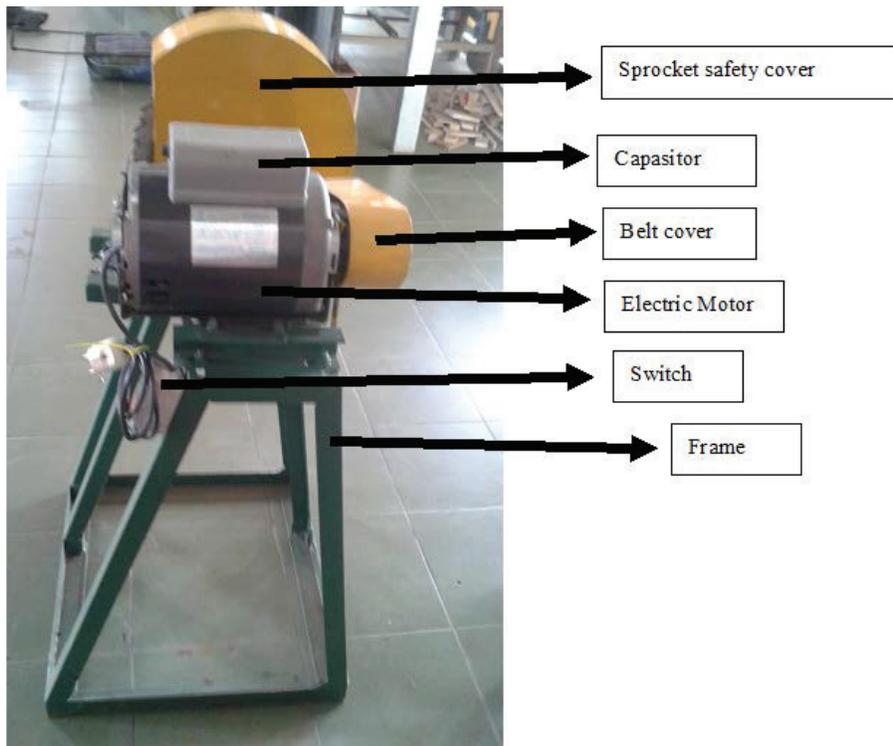


FIGURE 2. The coconut shell breaker looks sideways.

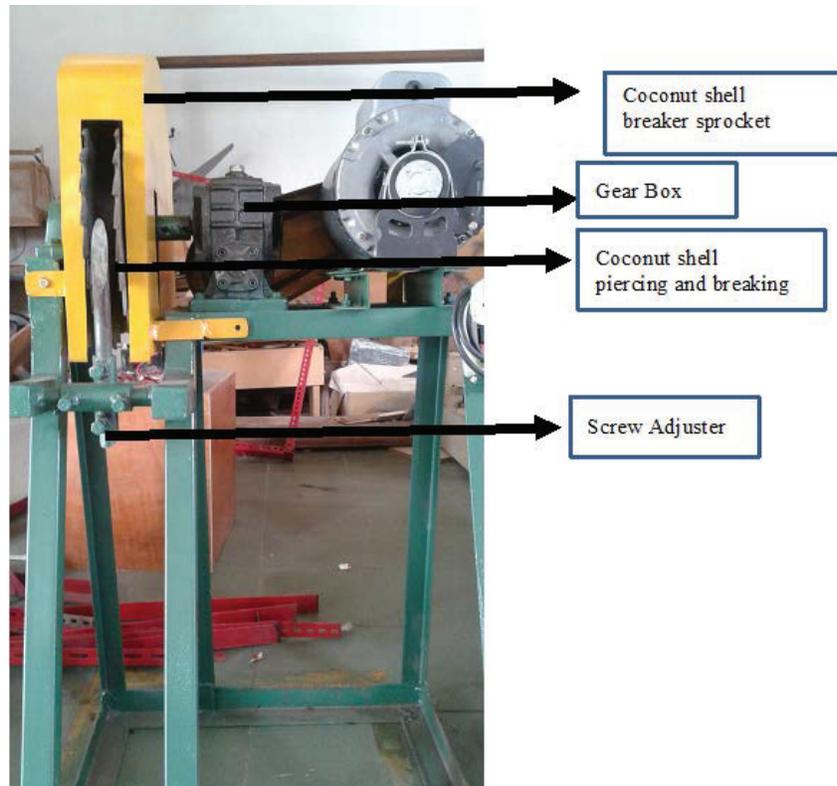


FIGURE 3. The coconut shell breaker looks front view.

The specifications of this coconut shell breaker are:

1. Tool dimensions: length = 60 cm, width = 60 cm, height = 85cm.
2. Materials from carbon steel, stainless steel.
3. The drive uses a 1:50 gear box and an AC motor $\frac{3}{4}$ hp.
4. The capacity of the tool to break the coconut shell is 1 coconut per minute.

The capacity of coconut shell breaking equipment is 1 coconut per minute, but in average, coconut home industry only processes 100 coconuts per day so that the use and utilization of this tool is not maximized.

The cost of making a coconut shell breaker with piercing and breaking gear techniques is around Rp. 7,000,000,- and it is affordable for the home industry or the SMEs. Electricity needs and costs of electricity use in the coconut shell breaker with a motor drive with a capacity of 1.5 hp with daily working time for 8 (eight) hours with a price of kwh electricity/hour is Rp. 1500,-, then:

$$\begin{aligned} \text{Electricity} &= \text{large power (kwh)} \times \text{working time} \times \text{electricity price /Kwh} \\ &= 1.0 \text{ kwh} \times 8 \text{ hours} \times \text{Rp. } 1,500, - \\ &= \text{Rp. } 12,000, - \end{aligned}$$

If on average the coconut home industry processes 100 coconuts, then if the process of breaking coconut shells done every day for 8 (eight) hours, the price of the service for solving coconut shells is Rp. 500 per coconut. Then, the advantage gained with the use of coconut shell breakers is as follows:[8]

Electricity costs 1 day (8 hours) = Rp. 12,000,- per day.

$$\begin{aligned} \text{Depreciation costs} &= \frac{\text{selling price of machine}}{\text{life time}} \\ &= \frac{\text{Rp. } 7,000,000}{3 \text{ years} \times 300 \text{ working days}} \\ &= \text{Rp. } 7800,- \end{aligned}$$

$$\text{Machine benefits} = (8 \text{ hours} \times 100 \text{ coconut} \times \text{selling price of machine}) - \text{electricity cost (8 hours)} - \text{Depreciation costs}$$

= (800 x Rp. 500) – Rp. 12,000 – Rp. 7,800
= Rp. 380,200,-
Payback period = Selling price of machine/Machine benefits
= 7,000,000 / 380,200
= 18.4 = ±18 days

Then, the payback period can be obtained within ±18 days.

CONCLUSION

Research on the activities of designing and making coconut shell breakers have been conducted. In overall, several points can be concluded as follows:

1. The components of shell breaker consist of: sprocket safety cover, capacitor, belt cover, electric motor as a drive, switch on/off, frame, coconut shell breaker sprocket, coconut shell piercing and breaking, gear box and screw adjuster.
2. The capacity of the tool to break down the coconut shell is one coconut per minute.
3. With the price of making a tool of Rp. 7,000,000,- with a payback period of ± 18 days, this tool can be implemented in coconut-producing areas for post-harvest processing.

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