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A Bench-Top Machine for Oil Palm Mesocarp Separation

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Abstract

Palm oil is rich in carotenoids and the major component of its glycerides is the saturated fatty acid palmitic. Because of its economic importance as high-yielding source of edible and technical oils, the oil palm is now grown as a plantation crop in most countries with high rainfall in tropical climates within 10 of the equator. The individual fruit ranging from 6 to 20 gm, are made up of an outer skin (the exocape), a pulp (mesocarp) containing the palm oil in a fibrous matrix; a central nut consisting of a shell (endocarp); and the kernel, which itself contains an oil, quite different to palm oil, resembling coconut oil (Poku, 2002). Nowaday in Thailand there is no small-scale suitable machine for farmers to separate palm mesocarp from palm nut. This research aims to develop a machine to separate palm fruit mesocarp to yield palm oil of better quality. The machine has four units, namely a mechanical power unit, feed unit, mesocarp milling unit, and discharge unit. The vital part is the mesocarp milling disc, which is the main report of this paper. There are three types of discs according to the surface typography under this study: 1) a disk with small holes and rectangular steel bars on the disk surface; 2) a disk with small holes, each with 1.2 centimeter diameter; 3) a disk with small holes and small steel items on the disk surface. It was found that the highest yield was obtained from the disk with small steel items and can separate mesocarp cleanly from the palm fruit.

1. Introduction

Oil palm is economically important because of its high-yield of edible oil. Oil palms are now grown in large plantation in many countries with high rainfall and tropical climate, within 10 degrees from the equator. The individual fruit range in size from 6 to 20 gm, and have an outer skin (exocape), pulp (mesocarp) containing the palm oil in its fibrous matrix, and a central nut. The nut consists of a shell (endocarp) and a kernel that contains oil, similar to coconut oil [3]. Palm oil milling is normally a large industry with intense investment cost. Small indigenous industry has adopted the coconut oil screw presses, but yields mixed oil from the mesocarp and the nuts. The mixed oil is considered as low-quality oil in the market view point. As its high potential for biodiesel production and the subsequent renewable energy strategy, Thailand has pushed forward a plan to increase her palm oil production. However, large plantation is not possible for the limited agricultural land. Many small rubber plantations were replaced by oil palm trees. To cope with the scattering production, there is a pressing need for small-scale milling equipment which capable to

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extract mesocarp oil only. This paper reports the design, build and test of a bench-top equipment to prove the concept which is expected to be suitable for further small-scale machine development.

1.1. Design Concept

Product designers habitually balance on the verge of arts, crafts and science, while customarily co-operating in teams consisting of designers and representatives from other fields of expertise, they might be rather discerning in identifying the set of implements to draw from. Such instruments, or more specifically tools and techniques, can significantly further design projects and the way in which those projects are executed. Creativity and decision-making are major components of design projects [1]. In general in engineering as we design new products and systems, we utilize science, and engineering methods and tools to manage the complexity by transforming the problem from complex to manageable and controlled [2]. The design of a bench-top equipment, we utilize science, and engineering methods to reach pressing need for small-scale milling equipment which capable to extract mesocarp oil. The design concept borrowed traditional manual rice milling machine, where rough surface mill out the rice husk, which, in this case represented by the mesocarp.

1.2. A Bench-Top Machine for Oil Palm Mesocarp Separation

The machine to separate palm mesocarp from palm nut was designed and constructed for oil palm research unit in order to serve small farmers. It comprises of 4 units namely, a mechanical power unit, feed unit, mesocarp milling unit, and discharge unit. Fig. 1 shows the designed machine. It's frame is made of steel, and the bottom of frame houses a motor connected via gears to the mesocarp milling unit, with linkage to the feed unit on top of the frame. The output unit is between the motor and the mesocarp milling unit.

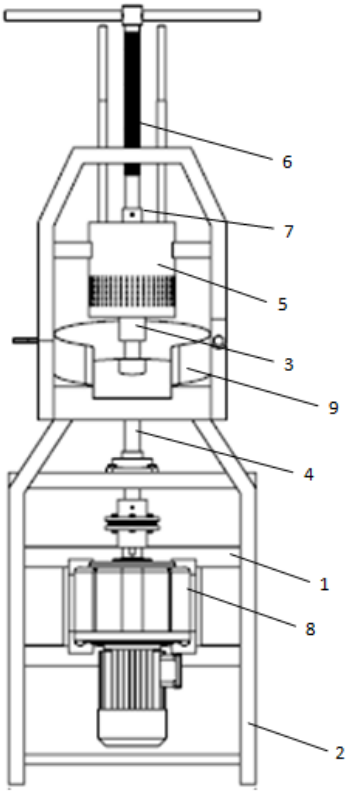

Figure 1: Drawing of a bench-top machine for oil palm mesocarp separation.

The bench-top machine for oil palm mesocarp separation (Fig. 1, Fig. 2) consists of the following parts:

1 - structure frame
2 - tripod
3 - disk
4 - axle
5 - bucket
6 - screw
7 - lid
8 - motor
9 - tray

Materials used to construct the machine that separates palm mesocarp from palm nut were as follows:

1. stainless steel
2. metal sheet
3. metal structure
4. knot and skrew
5. motor and gear 2HP, 380V 10RPM
6. flanged rigid couplings
7. flange bearings UCF 208-40
   control box

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Figure 2: The palm mesocarp separation machine.

1.3. Testing of the bench-top machine for oil palm mesocarp separation

On testing the efficiency of this machine we used three types of separation disk: 1) a disk with 52 rectangular steel bars (1x3 centimeters) on the disk surface (Fig. 3(a)); 2) a disk with 36 holes, each with 1.2 centimeter diameter (Fig. 3(b)); and 3) a disk with 32 cylindrical rounded steel protrusions (0.8x3.5 centimeters) fixed flat on the disk surface (Fig. 3(c)). In the efficiency tests the third option separated palm mesocarp cleanly from palm nut.

(a) Separation disk with 52 rectangular steel bars (1x3 centimeters) on the disk surface.

(b) Separation disk with 36 holes, each with 1.2 centimeter diameter.

(c) Separation disk with 32 rounded steel protrusions (0.8x3.5 centimeters) on the disk surface.

Figure 3: Different separation disks (a, b and c).

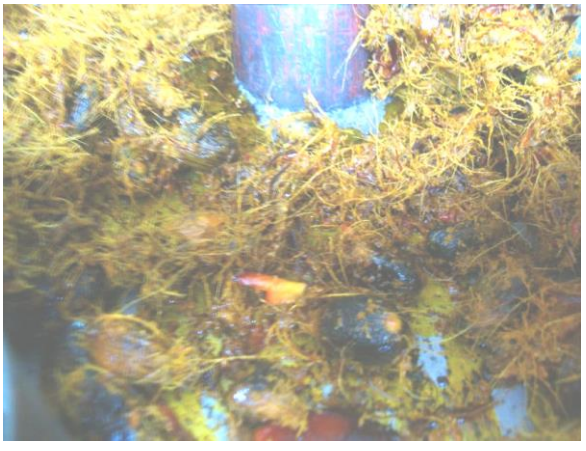

Figure 4: Palm mesocarp and palm nuts after mechanical separation with the machine described using the third option.

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Table 1. The efficiency test result of a bench-top machine for oil palm mesocarp separation.

Types of separation disk	Microwave Palm			Vapor Palm		
	Palm Weight (g)	Separation Time (minutes)	Separation Characteristic	Palm Weight (g)	Separation Time (minutes)	Separation Characteristic
Disk with 52 rectangular steel bars	1001	2	The disk can't give clean separation of palm mesocarp from palm nuts.	999	2	The disk can't give clean separation of palm mesocarp from palm nuts.
Disk with 36 holes	1003	2.07	The disk can't separate palm mesocarp from palm nuts.	1003	2.42	The disk can't separate palm mesocarp from palm nuts.
Disk with 32 steel items	1005	2.01	The disk can give clean separation of palm mesocarp from palm nuts.	1001	2.28	The disk can give clean separation of palm mesocarp from palm nuts.

The efficiency test result of a bench-top machine for oil palm mesocarp separation shows in table 1. Disk with 52 rectangular steel bars can't give clean separation of palm mesocarp from palm nuts, disk with 36 holes can't separate palm mesocarp from palm nuts, but disk with 32 steel items separated palm mesocarp cleanly from palm nut.

The initial users of this laboratory bench-top machine include researchers, teachers, and students who studying palm oil production. Later on similar machines can help farmers separate palm mesocarp from palm nut, so that they can compress palm mesocarp and produce palm oil themselves, which is a new option in managing the economy of the farm. The palm fruit can be easily and safely separated into palm mesocarp and palm nut, and the power consumption is low, while the machine is robust and should require little maintenance. The palm nuts were not cracked in our testing. Fig. 4 shows palm mesocarp and palm nuts after their separation, and demonstrates the cleanness of this separation.

2. Conclusion

We designed a bench-top mechanical separation machine for the process palm fruit so that mesocarp and palm nuts can be collected. The design of the machine ensures safe operation, the energy requirement is low, and the design is robust for practical use. In efficiency tests, a separation disk with rounded protrusion on the surface of a perforated disk gave clean separation of palm mesocarp from palm nuts, and the processing required about 2 minutes per 1 kilogram of palm fruit. Aside from research use in the laboratory, similar devices could be useful to small-scale processing on farms.

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References

[1] E. Lutters, F.J.A.M. van Houten, A. Bernard, E. Mermoz, C.S.L. Schutte. Tools and techniques for product design. CIRP Annals – Manufacturing Technology 63, 607–630. (2014).
[2] W. ElMaraghy, HA. ElMaraghy, T. Tomiyama, L. Monostori. Complexity in Engineering Design and Manufacturing. CIRP Annals – Manufacturing Technology 61(2):793–814. (2012).
[3] K. Poku: Small-scale palm oil processing in Africa. FAO agricultural services bulletin N148, FAO, Roma. (2002).

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