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Evaluation of Performance for Young Coconut Husk Processing Machine and Its Product Quality

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Abstract
Fresh coconut water industry in Malaysia has grown as its demand has increased tremendously at about 32.12 million young coconuts per month. Hence, production of husk from the coconut industry has also increased and contributed to the problem at disposal level. A young coconut husk processing machine to produce cocopeat and fiber has been developed to provide added value to the residue. An assessment of performance for the machine and its products quality has been done. The assessment of quality for cocopeat was done by using rotary screener that equipped with 16 mesh nets and multi-layer shaker. The evaluation results showed that the machine capacity of the young coconut husk extractor was up to 514.9 kg / hour with the average weight ratio of unfiltered cocopeat and fiber produced at 65.4% and 34.6% respectively. Meanwhile the results of cocopeat quality evaluation have found only 5.7% and 0.6% fiber contained in the cocopeat mixture after extraction and filtration respectively. Utilization of this technology by small entrepreneurs is necessary to develop a new dimension of waste management from the young coconut water industry and also create a competitive industry chain for building local socio-economic.

Keywords: young coconut husk, cocopeat, fiber, husk processing machine, rotary screener

Introduction

Coconut is a popular palm and is grown in more than 90 countries worldwide. In Malaysia, it is the 4th important crop in terms of acreage after oil palm, rubber and paddy (Christoper J.B., 2018). The coconut industry has significant socio-economic implications as it provides a source of revenue and employment to households. In addition, it supports a number of vibrant small and medium coconut-based processing industries and exporters.

In Malaysia, 95% of coconut growers are smallholders with an average yield of 5,966 kg coconuts / hectares in 2016. Coconut production is increasing from 2016 to 2018 at 504,773 MT to 538,685 MT (Anon, 2018). The demand for young coconut has begun to grow with government initiatives, especially the Ministry of Agriculture in the 1990s through the encouragement of drinking water young coconut (Mohd Rashid, R. et al., 2016). Young coconut can be defined as at an immature stage, contains mainly water and a little jelly-like meat instead of the hard white flesh found in mature coconuts. The young coconut which was initially just as a non-commercialized beverage has turned out to be popular. The high demand and market price has attracted the interest of farmers to grow coconuts.

Based on the results of the survey conducted by Mohd Hafizudin et al. (2016) showed that 46.0% of consumers preferred Pandan varieties and followed by Matag (12.3%). Meanwhile, another 24% did not show a tendency to young coconut variety. A total of 32.12 million young coconuts per month were estimated to fulfill the demand based on the results of the study.

The increase in demand for young coconut has contributed to the increase in residual products such as coconut husk. As much as 44% of coconut husk is underutilized and disposed of in open field (Tafsir S. and Mohd Hafizudin Z., 2018). Disposal methods of coconut husk that are not systematically removed and burned openly can cause environmental pollution. The collection of young coconut husks in the coconut processing center can be benefited by establishing a local mechanization system to process the husk into value-added products such as cocopeat and coir fiber. Cocopeat can be sold at RM 7 / bag or RM 1.40 / kg while coir fiber can be sold at RM 1.20 / kg (Mohd Zaffrie, MA et al. 2018). Cocopeat can be used as planting media in fertigation cropping system while coir fiber can be used as industrial input material. Evaluation of the machinery that developed for the processing of young coconut husk has been carried out to identify its performance. It is able to improve the efficiency, quality and production of cocopeat and coir fiber systematically. Consequently, the use of this processing machinery may ensure the sustainability of the country's coconut industry as well as the local socio-economic development.

Materials and Methods

A young coconut husk processing machine was developed by the Engineering Research Center, MARDI. Performance assessment has been carried out on the machine and quality of the products produced namely cocopeat and coir fiber. The young coconut husk used in this machine evaluation was obtained from the young coconut water stalls around Bandar Baru Bangi.

Young Coconut Husk Processing Machine

The processing machine of young coconut husk as shown in Figure 1. It consists of two main function sections which are extraction mechanism and scraper mechanism. Both of these mechanisms were driven by 11 HP capacity engine via belting mechanism. The extraction mechanism comprises of several key components to enhance efficiency of the mechanical extraction process such as spike, cylinder drum, combing devices, filtering rods and fin plate whereas the scraper mechanism was installed under the filtering rod to smoothen the extraction operation by preventing the clogging of cocopeat. The scraper mechanism has been designed to operate continuously at speed of 0.03 m/s through mechanical concepts. It was equipped with components such as speed reducer, chain and sprocket.

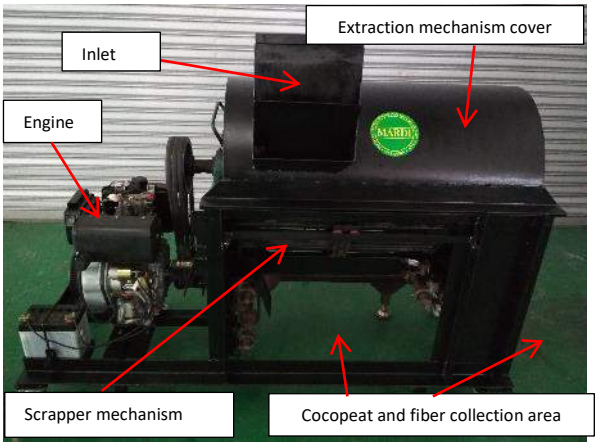

Figure 1: Young Coconut Husk Processing Machine

Extraction Process of Cocopeat and Coir Fiber from Young Coconut Husk

Operation of young coconut husk processing was repeated 10 times to determine the actual processing capacity of the machine. A total of 300 kg of young coconut fiber was used for the entire assessment operation. The assessment operation was performed by using an operator to fill the young coconut fiber to be processed through the input funnel. The outputs from the extractor were discharged and collected at different outlet path. Data such as the weight of the young coconut fiber, cocopeat and fiber produced and the processing period were recorded for calculation of machine capacity and gross product ratio. The machine capacity was calculated by using the following formula:

$$Machine\ Capacity\ (\frac{kg}{h}) = \frac{Total\ Weight\ of\ Material\ (kg)}{Duration\ of\ Processing\ (h)} \quad (1)$$

Meanwhile, the gross product ratio was calculated using the following equation:

$$Percentage\ of\ gross\ cocopeat\ weight\ (\%) \quad (2)$$

$$= \frac{Weight\ of\ gross\ cocopeat\ (kg)}{Weight\ of\ gross\ cocopeat\ and\ fiber\ (kg)} x\ 100$$

$$Percentage\ of\ gross\ fiber\ weight\ (\%) \quad (3)$$

$$= \frac{Weight\ of\ gross\ fiber\ (kg)}{Weight\ of\ gross\ cocopeat\ and\ fiber\ (kg)} x\ 100$$

Moisture content of the young coconut husk and cocopeat also recorded as a reference. Determination of moisture content for these materials was performed by using moisture balance AND MX-50. A total of 1g sample was used for each assessment at a temperature of 105 ° C (Mani et al. 2004). Five samples for each material were used to perform this evaluation.

Quality Evaluation of Cocopeat from Young Coconut Husk

Quality evaluation of cocopeat produced via young coconut husk processing machine was performed for 5 samples to measure its product ratio only. Control of cocopeat quality was necessary to prevent the excessive content of fiber in the cocopeat mixture. Filtering process of cocopeat was done by using a rotary screener as displayed in Figure 2 at a speed of 7 RPM. The rotary screener is developed by MARDI and equipped with a 16 mesh of a plastic net.

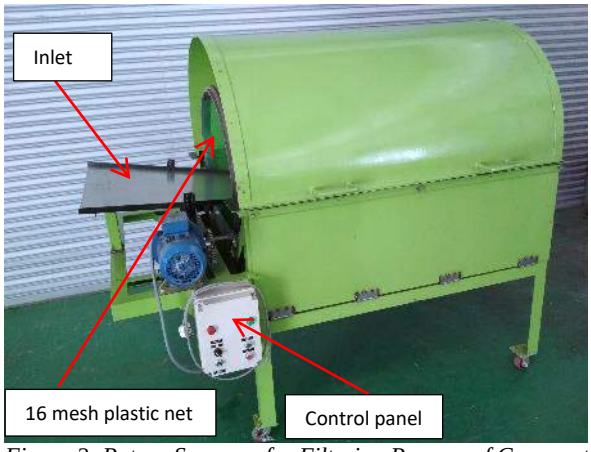

Figure 2: Rotary Screener for Filtering Process of Cocopeat

Total weight of filtered cocopeat and fiber were recorded for calculation of the weight ratio. Then, the cocopeat mixture that filtered by using rotary screener was further analyzed in the laboratory by using a multi-layer shaker to determine the percentage of fiber that was still contained. The weight of fiber obtained from the analysis was recorded for computation of cocopeat and fiber ratio in ready-to-sell products. The percentage of the cocopeat and fiber is calculated using the following formula:

$$Percentage\ of\ cocopeat\ weight\ (\%) \quad (4)$$

$$= \frac{Weight\ of\ filtered\ cocopeat\ (kg)}{Weight\ of\ filtered\ cocopeat\ and\ fiber\ (kg)} x\ 100$$

$$Percentage\ of\ fiber\ weight\ (\%) = \frac{Weight\ of\ filtered\ fiber\ (kg)}{Weight\ of\ filtered\ cocopeat\ and\ fiber\ (kg)} x\ 100 \quad (5)$$

Results and discussion

Machine Capacity of Young Coconut Husk Extractor

Results of machine capacity analysis for the young coconut husk processing machine as shown in Figure 3. In average, the extractor was able to process 387.0 kg/h of the husk. The value has indicated an upward trend.

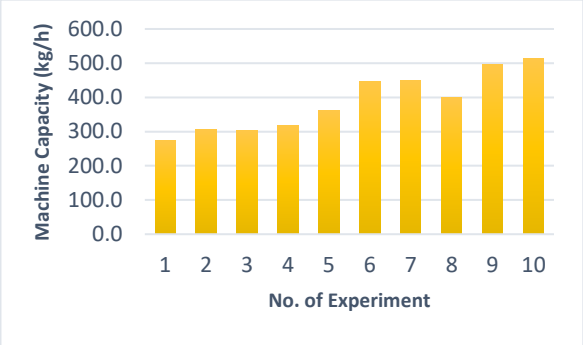

Figure 3: Results of Machine Capacity for Young Coconut Husk Processing Machine

The factors that influence this trend were the operator efficiency during processing and the factors of material used such as size and moisture content. Moisture content of the collected young coconut husk varies from 75.21% to 93.72% due to several factors. The factor that may affect moisture content was the exposure of the material to the environment within a certain period before being collected for processing and irregular size of the young coconut husk pieces. Direct exposure to sunshine and small cutting size have contributed to faster drying rates and reduced the moisture content of the husk (Onwuka U.N and Nwachukwu G., 2013).

Meanwhile, result of the gross product ratio for cocopeat and fiber that extracted by the machine as shown in Table 1. The average result has indicated that the outputs were containing 34.6% and 65.4% of fiber and cocopeat respectively.

Table 1: Results of product ratio of cocopeat and fiber after extraction process

Sample N	Cocopeat (%)	Fiber (%)
1	57.9	42.1
2	60.2	39.8
3	67.9	32.1
4	68.3	31.7
5	72.7	27.3

Product Quality of Cocopeat from Young Coconut Husk

Cocopeat from the extractor was filtered by using the rotary screener to determine fiber content in the cocopeat mixture. Results of the screening process as shown in Table 2. The average value of fiber in the cocopeat was 5.7% only and the picture of cocopeat before screening process as displayed in Figure 4.

Table 2: Results of product ratio for cocopeat mixture after filtered via rotary screener

Sample N	Fiber (%)	Cocopeat (%)
1	5.8	94.2
2	4.6	95.4
3	5.4	94.6
4	6.1	93.9
5	6.4	93.6

Figure 4: Extracted cocopeat before screening process

Meanwhile the result of product ratio for cocopeat after filtered via rotary screener and multi-layer shaker as displayed in Table 3. Based on the result of the analysis, the cocopeat that ready to market only contains 0.62 % of fiber in average. At this level of fiber content, the product quality can be accepted by consumer. The picture of cocopeat after screening process as indicated in Figure 5.

Table 3: Results of ready to market product ratio for cocopeat after analyzed via multi-layer shaker

Sample N	Fiber (%)	Cocopeat (%)
1	0.8	99.2
2	0.5	99.5
3	0.7	99.3
4	0.6	99.4
5	0.5	99.5

Figure 5: Cocopeat after screening process

Conclusion

Development of young coconut husk processing machine is necessary to enhance the agro-waste to more valuable products. This machine is capable to process 514.9 kg / h of the coconut husk that contains 65.4% of cocopeat and 34.6% of fiber. Utilization of rotary screener to improve cocopeat mixture quality has decreased the amount of fiber to 0.62%. Therefore, processing of the young coconut husk by using both machines developed by MARDI is capable of producing quality value-added products. It needs to be beneficial to ensure the sustainability of the growing coconut industry.

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