Research Article

Design and Development of the Separation and Extraction of Palm Oil by Using Screw Extractor Machine

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Abstract
The objectives of this research were to design and develop palm seed separating machine and palm oil pressing machine. According to the design of a grille for separating palm seed, the diameter of the grille was 39.2 cm. The diameter of the hole of the grille was 1.5 cm in diameter. The 4×4 cm steel tube was used to construct the structure of the machine. The machine was 70 cm wide, 70 cm long and 70 cm high. The tank for conveying palm seeds was made of sheet steel which was rolled into the cylinder with 40 cm in diameter and 40 cm high. There were two exits at both sides. The separating rack was attached to the shaft. The shaft assembled with the grille was made by turning it to the thread in order to be able to assemble to the grille. The V-B54 belt was responsible for sending power from the motor to the grille. There were 4 sizes the pulley used for speed test; 2, 3, 4, and 6 in. Each of which was powered from the motor to the belt and from the belt to the grille. The results from the experiment showed that for separating palm seeds of 1 kg, it took 35 s at 483, 725, and 967 rpm. At 483 rpm, it provided the best performance. The efficiency of separating seeds was 91.76% which can separate palm seeds at 102 kg/h. The electricity consumption was 0.86 kWh. The width of palm oil pressing machine was 55.5 cm with the length of 53 cm and the height was 56 cm. The cylinder was made of steel pipe with the thick of 1.4 cm. The width of the square-shape inlet palm meat was 16 cm and the length was 19 cm. The length of the cylinder was 40 cm. The diameter of the cylindrical-shape outlet palm scrap was 10 cm. The length of the pulley was 63 cm and the pitch was 3.4 cm long. The diameter of the screw compressor was 9.6 cm. The motor power was 1-phase 3 hp. V-Belt, 72-inch 2 lines and 55-inch 2 lines. The result showed with the speed of 110, 133, and 155 rpm. Each round took 3 times which were 5, 10, and 15 min. The best speed of palm oil pressing machine pressing palm meat before dried with hot air was 155 rpm. The efficiency of pressing was 36.51%. Also, the best speed of palm oil pressing machine pressing palm meat after dried with hot air was 110 rpm. The efficiency of pressing palm oil was 27.09%. Palm oil can be squeezed by palm oil pressing machine to 4 kg/h by using the electric power of 1.2 kWh.

Keywords: Palm seed separating machine, Palm oil pressing machine, Before dried with hot air, After dried with hot air

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1 Introduction

Production of biodiesel has been greatly supported by the government in order to push for the production of biodiesel to increase to 5.97 million liters per day in 2021. Now, the capacity of the production of biodiesel is only 1.62 million liters per day according to the Alternative Energy Development Plan (AEDP 2012–2021) of the government [1], [2]. Palm is a major oil crop [3]–[5] in the production of biodiesel [6]. Palm oil can be obtained from its peel and kernel [7]. At present, oil from palm can be processed by two ways [8], [9]. The first method can be done by separating peel from kernel. Then palm oil and palm kernel oil are obtained. Palm kernel oil [10]–[14] is widely used in the pharmaceutical or cosmetic industry because it is good quality oil. Palm oil is commonly used to produce biodiesel. Another way is to obtain oil can be done by pressing both peels and kernels together. The cost of separating peel and kernel is not required for this method. The oil obtained this way is Grade B oil [15]. Thus, to achieve the maximum benefit use of palm oil, peel and kernel should be separated. This research study, therefore, focused on pressing crude palm oil from peel by separating peel from kernel. Separated peel would be pressed immediately after the separation. For kernel, it would be sorted out in order to be used for other purposes.

2 Research Methodology

2.1 *Research plan*

This study aimed to study the design of palm seed separating machine and palm oil pressing machine using spiral expression machine [16]–[18] shown in Figures 1 and 2. In this study, the instruments were constructed in order to collect the data from the real machines. The machine was created to study the variables affecting the efficiency of the production of palm oil. The results were analyzed with the theories.

The variables considered in terms of data collection were divided into three types: assigned variables, independent variable and dependent variable.

1) Assigned variables referred to the variables with constant values. For the data collection, the variables which were controlled included palm seed separating machine and palm oil pressing machine, the

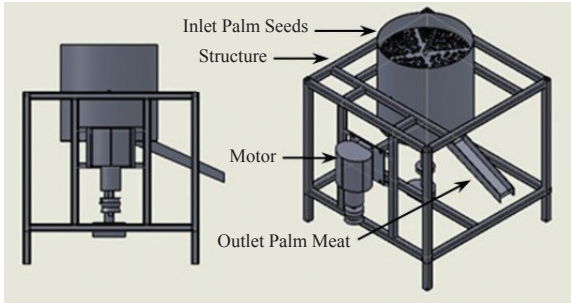

Figure 1: Palm seed separating machine plan.

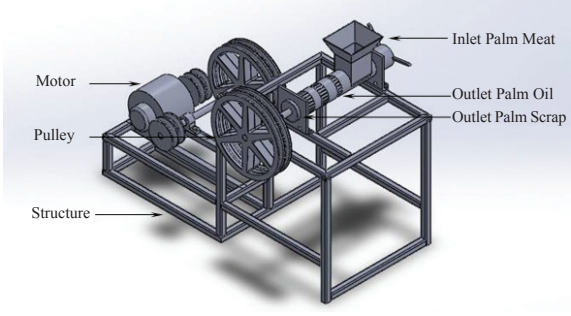

Figure 2: The plan of palm oil pressing machine.

operating time of palm oil production per round and the size of palm oil pressing machine, which would be informed in the next topic. The operating time of palm oil production per round was the assigned variable because the speed of the control of the palm oil production can be set in order to control the thickness of palm peel. The speed of production varied depending on the size of palm. In this study, the speed was set.

2) Independent variable was the variable indicating the performance of palm oil production which was the size of palm.

3) Dependent variable was the value that was changed when the independent variable was changed. In this study, the dependent variable was the weight of palm.

The procedures and the methods of the palm oil production process were detailed in Figure 3.

2.2 *The machine used in the study*

2.2.1 Palm seed separating machine

The structure of palm seed separating machine. The design focused on the safety of the equipment with

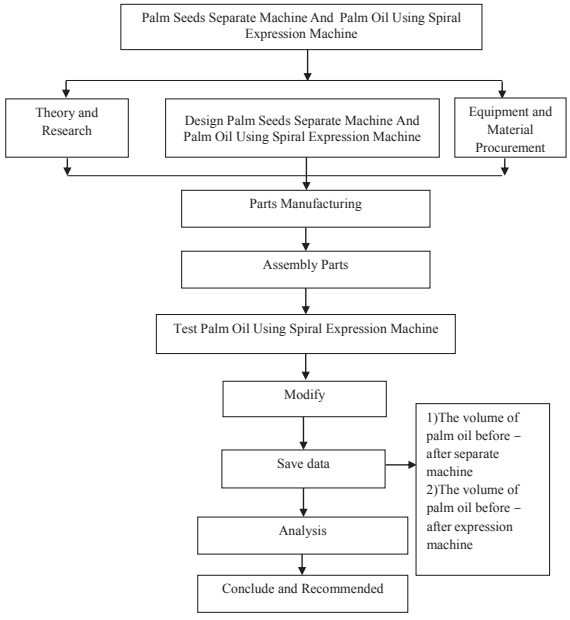

Figure 3: The research process.

Figure 4: Palm seed separating machine.

Figure 5: Palm oil pressing machine.

inexpensive cost and it must be easy to maintain. The grille for separating palm seeds was designed and installed to let the seeds fall down to the bottom for more effectiveness in separating seeds and meat of palm apart.

In this study, the palm seed separating machine was constructed. The diameter of the grille was 39.2 cm. The diameter of the hole of the grille was 1.5 cm in diameter. The 4×4 cm steel tube was used to construct the structure of the machine. The machine was 70 cm wide, 70 cm long and 70 cm high. The tank for conveying palm oil seeds was made of sheet steel which was rolled into the cylinder with 40 cm in diameter and 40 cm high. There were two exits at both sides. The separating rack was attached to the shaft. The design of the shaft shown in Equation (5). The shaft assembled with the grille was made by turning it to the thread in order to be able to assemble the grille. The design of the motor shown in Equation (3) and the V-B54 belt was responsible for sending power from the motor to the grille. There were 4 sizes the pulley used for speed test; 2, 3, 4, and 6 in shown in Figure 4.

2.2.2 Palm oil pressing machine

The structure of palm oil pressing machine was made from 4×4 cm steel tube. The width of palm oil pressing machine was 55.5 cm with the length of 53 cm and the height was 56 cm. The cylinder was made of steel pipe with the thick of 1.4 cm. The width of the square-shape inlet palm meat was 16 cm and the length was 19 cm. The length of the cylinder was 40 cm. The diameter of the cylindrical-shape outlet palm scrap was 10 cm. The length of the pulley was 63 cm and the pitch was 3.4 cm long. The design of the shaft shown in Equation (5). The diameter of the screw compressor was 9.6 cm [19], [20]. The design of the motor shown in Equation (3). The motor power was 1-phase 3 hp [21]. The motor was adhered into the structure of palm oil pressing machine [22] shown in Figure 5.

2.3 *Experiment process*

The factor of the design and the development of the palm seed separating machine which was investigated was the speed of the grille used to separate palm shells and seeds. When the machine was assembled and the materials were readily prepared for the test, the next step was to test the performance of the palm seed separating machine and record the results. The results of speed at 3 levels, including 483, 725, and 967 rpm

were recorded. The speed ratio was derived from Equation (4). Each test was repeated three times for 35 s. The process of each repeat test was as follows.

1. Checked the condition and suitability of the palm seed separating machine before each experiment.

2. Weighted dried palm oil from the drying for 1 kg at a time and counted the number of the palm used in the experiment.

3. Set the speed of the palm seed separating machine at level 1 (483 rpm) and operated the machine without palms for testing the machine.

4. Put the palm which was already weighted to the tank for separating palm meat from the seeds.

5. Started the machine and timed for 35 min.

6. Put the container at the exit for containing the palm meat and seeds.

7. When the machine finished running, stopped the machine and weighted palm meat and seeds were dropped after the experiment.

8. Repeat the experiment process from step1 to 6.

9. Repeated from step 3 by changing speed to level 2 (725 rpm) and level 3 (967 rpm).

When the parts were assembled and the tools for the experiment were ready, the next research process was to test the operation of the palm oil pressing machine in order to record the experiment results in terms of time spent in pressing palm oil before dried with hot air and after dried with hot air from 1 kg of palm, the next step was to test the performance of the palm oil pressing machine and recording the results. The results of 3 speed levels that included 110, 133 and 155 rpm were recorded. The speed ratio was derived from Equation (4). The sequences of the experiments were as follows.

1. Prepared 1 kg of palm meat (palm kernel processed by separating peel and kernel).

2 Pressed ON bottom at the machine and the motor would drive the pulley and belt.

3. Placed the palm meat at the inlet and the screw compressor would press the palm meat and palm oil was obtained.

4. After palm oil had been pressed, the test was completed. Then pressed OFF button and cleaned the machine.

5. Weighed palm oil pressed by palm oil pressing machine to compare the weight of palm with peel before being pressed by the machine and the weight of palm meat from the machine.

6. Repeated the process from No. 1 to No. 6 with the speed of 110, 133, and 155 rpm. The times spent each round were 5, 10, and 15 min, respectively.

7. Recorded the results.

3 The Theories Used in the Calculation

3.1 *Calculation of the efficiency of palm seed separating*

The efficiency of palm seed separating can be calculated from the ratio of number of seeds in the separating machine per total palm seeds input [23].

$$\eta = \frac{W_{out}}{W_{in}} \times 100\% \tag{1}$$

When η was the efficiency of palm seed separating (%)
W_{out} was number of seeds in the separating machine
W_{in} was total palm seeds input to the machine

3.2 *Calculation of the efficiency of pressing palm oil*

The efficiency of pressing palm oil can be calculated from the ratio of the weight of crude palm oil to the weight of the palm meat entered to the machine [23].

$$\eta = \frac{W_{out}}{W_{in}} \times 100 \tag{2}$$

When η was the efficiency of pressing palm oil (%)
W_{out} was the weight of crude palm oil (g)
W_{in} was the weight of the palm meat entered to the machine (g)

3.3 *Calculation of the size of the motor*

Load of motor referred to the number of power that the motor must be able to power up. That is to say, the motor power must be enough to be able to drive the machine, or called shaft power. This was a critical part, but the ability to drive the load was torque and (P) shown in the Equation [20].

$$P = \frac{2\pi\tau N}{60} \tag{3}$$

When P was motor power (kW)
τ was torque (N.m)

N was speed round (rpm)

3.4 *Calculation of the speed ratio*

The rate between the transmission shaft and the receiving shaft as a belt is the power transmission [24].

$$m_\omega = \frac{n_1}{n_2} = \frac{D_2}{D_1} \quad (4)$$

When m_ω was speed ratio
n_1 was transmission shaft speed (rpm)
n_2 was receiving shaft speed (rpm)
D_1 was diameter transmission pulley (mm)
D_2 was diameter receiving pulley (mm)

3.5 *Calculation of the size of shaft*

The size of the transmission shaft and receiving shaft of the machine can be calculated from Equation [25].

$$d^3 = \frac{16}{\pi\tau_d}\left[\left(C_t T\right)^2 + \left(C_m M\right)^2\right]^{1/2} \quad (5)$$

When d was diameter shaft (mm)
τ_d was shear stress (N/mm^2)
T was twisted moment (N/mm)
M was Moment of bending (N/mm)
C_t was fatigue of twisting
C_m was fatigue of bending

3.6 *Calculation of the average*

The average data can be calculated from the relationship between the data and the total amount of information. Show Equation [26].

$$\overline{x} = \frac{\sum_{i=1}^{n} x_i}{n} \quad (6)$$

When $\overline{x}$ was average of data
x_i was data i
n was total amount of data

4 Results and Discussion

The analysis of the results of the experiment of palm seed separating machine and palm oil pressing machine was divided into two parts as follows.

4.1 *The analysis of the results of palm seed separating machine*

The details of the experimental results of palm seed separating machine were as follows. It was found that for the operation of palm seed separating machine at 483 rpm, the number of palms after the experiment decreased slightly. After the experiment, the palm seeds were quite complete, but some palm meat was attached to the seeds. The palm peels and meat were perfect, but there were some seeds mixed in them shown in Table 1.

For the operation of palm seed separating machine at 725 rpm, the number of palms after the experiment decreased slightly. After the experiment, some palm seeds were cracked and some palm meat was attached to the seeds. The palm peels and meat were perfect, but there were some seeds mixed in them shown in Table 1.

For the operation of palm seed separating machine at 967 rpm, the palm seeds after the experiment were very wasteful and falling down the grille hole shown in Table 1.

Table 1: Palm peels, palm meat and palm seeds after the experiment with 483, 725, and 967 rpm

Speed	Palm Peels, Palm Meat, and Palm Seeds
483 rpm	
725 rpm	
967 rpm	

Separating 99, 96, and 95 palm seeds at a speed of 483 rpm provided 88, 89, and 89 palm seeds, respectively. The efficiencies of the operation were 88.89, 92.71, and 93.68%, respectively, with the mean of 91.76%.

Table 2: The experimental results of separating palm seeds of 1 kg using palm seed separating machine

Experiment (time)	Speed (rpm)	Number of Palms (seeds)	Number of Palm Seeds after Experiment (seeds)	Palm Weight (gram)	Palm Seed Weight after Experiment (gram)
1	483	99	88	699.45	257.83
2	483	96	89	703.59	262.35
3	483	95	89	679.38	272.14
Mean	483	97	89	694.14	264.10
1	725	90	58	849.38	113.43
2	725	89	48	839.56	99.58
3	725	90	56	832.55	105.89
Mean	725	90	54	840.49	106.3
1	967	94	N/A	950.38	N/A
2	967	91	N/A	932.42	N/A
3	967	98	N/A	965.73	N/A
Mean	967	94	N/A	949.5	N/A

Note: N/A = not available

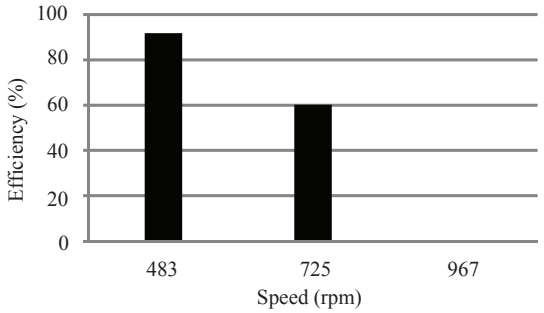

Figure 6: The chart of the efficiency of palm seeds separation at various speeds.

The efficiency and average of the data calculated following the Equations (1) and (6), respectively. Separating 99, 96, and 95 palm seeds at a speed of 725 rpm provided 58, 48, and 56 palm seeds, respectively. The efficiencies of the operation were 64.44, 53.93, and 62.22, respectively, with the mean of 60.20%. The efficiency and average of the data calculated following the Equations (1) and (6), respectively. For separating 94, 91, and 98 palm seeds at a speed of 967 rpm, it was found that the palm seeds after the experiment were a lot damaged and fell down through the grille holes. Therefore, the efficiency cannot be found out shown in Figure 6 and Table 2.

Table 2 showed the experimental results of separating palm seeds of 1 kg by using palm seed separating machine. From the results of the separation of palm seeds at three levels of speed, it was found that the speed at 483 rpm gave the highest efficiency of seed separation.

4.1.1 Results of the electricity consumption analysis

1. The palm seed separating machine can separate 102 kg of palm oil per hour. The electricity consumption was 0.86 kWh.

2. If the machine runs 8 h a day, it can separate 816 kg of palm oil and the total electricity consumption was 6.86 kWh or 27.44 baht.

4.2 *Analysis of pressing palm oil test results*

4.2.1 Results and analysis of the results of the experiment before dried with hot air

The results revealed that for the operation of palm oil pressing machine at a speed of 110 rpm at 5 min before dried with hot air, little amount of palm oil was obtained while the palm meat were left a lot as shown in Table 3.

According to the operation of palm oil pressing machine at a speed of 110 rpm at 10 min, palm oil was obtained more than that of at 5 min, but there was some palm meat left shown in Table 3.

According to the operation of palm oil pressing machine at a speed of 110 rpm at 15 min, it provided the highest amount of palm oil at the speed of 110 rpm and there was no palm meat left shown in Table 3.

Table 3: Palm oil obtained at a speed of 110 rpm at 5, 10, 15 min before dried with hot air

Time	Palm Oil	Palm Meat
5 min		
10 min		
15 min		N/A

Table 4: Palm oil obtained at a speed of 133 rpm at 5, 10, 15 min before dried with hot air

Time	Palm Oil	Palm Meat
5 min		
10 min		N/A
15 min		N/A

The results of the operation of palm oil pressing machine revealed that at a speed of around 133 rpm at 5 min before dried with hot air, little amount of palm was obtained and little amount of palm meat was left shown in Table 4.

According to the operation of palm oil pressing machine at a speed of 133 rpm at 10 min, palm oil was obtained more than that of at 5 min and there was no palm meat left shown in Table 4.

According to the operation of palm oil pressing machine at a speed of 133 rpm at 15 min, it provided the highest amount of palm oil at the speed of 133 rpm and there was no palm meat left shown in Table 4.

The results of the operation of palm oil pressing machine revealed that at a speed of around 155 rpm at 5 min before dried with hot air, the amount of palm oil was obtained higher than those of other speeds and palm meat was not left shown in Table 5.

According to the operation of palm oil pressing machine at a speed of 155 rpm at 10 min before dried with hot air, palm oil was obtained more than that of at 5 min and there was no palm meat left shown in Table 5.

According to the operation of palm oil pressing machine at a speed of 155 rpm at 15 min, it provided the highest amount of palm oil at the speed of 155 rpm and there was no palm meat left shown in Table 5.

Table 5: Palm oil obtained at a speed of 155 rpm at 5, 10, 15 min before dried with hot air

Time	Palm Oil	Palm Meat
5 min		N/A
10 min		N/A
15 min		N/A

From the operation of palm oil pressing machine at a speed of 110 rpm before dried with hot air using 1 kg of palm meat for 5, 10, and 15 min, respectively, the amount of palm oil obtained was 120.17, 171.28, and 233.06 g, respectively. The efficiency of the operation was 12.02, 17.13, and 23.31%, respectively. The average was 17.49%. The efficiency and average of the data calculated following the Equations (2) and (6), respectively. According to the operation of palm oil pressing machine at a speed of 133 rpm

before dried with hot air using 1 kg of palm meat for 5, 10, and 15 min, respectively, the amount of palm oil obtained was 76.87, 158.48, and 268.99 g, respectively. The efficiency of the operation was 7.68, 15.85, and 26.90%, respectively. The average was 16.81%. The efficiency and average of the data calculated following the Equations (2) and (6), respectively. For the operation of palm oil pressing machine at a speed of 155 rpm before dried with hot air using 1 kg of palm meat for 5, 10, and 15 min, respectively, the amount of palm oil obtained was 181.80, 304.15, and 365.05 g, respectively. The efficiency of the operation was 18.18, 30.42, and 36.51%, respectively. The average was 28.37%. The efficiency and average of the data calculated following the Equations (2) and (6), respectively and shown in Table 6.

Table 6: The results of pressing palm oil before dried with hot air

Speed (rpm)	Time (minute)	Weigh of palm (g)	Weight of palm after pressing (g)	Efficiency (%)
110	5	120.17	133.28	12.02
	10	171.28	197.63	17.13
	15	233.06	N/A	23.31
133	5	76.78	110.00	7.68
	10	158.48	N/A	15.85
	15	268.99	N/A	26.90
155	5	181.80	N/A	18.18
	10	304.30	N/A	30.43
	15	365.05	N/A	36.51

According to the pressing of palm oil at a speed of 110 rpm at 3 periods of time, 15 min provided the highest efficiency of pressing palm oil at 23.31% shown in Figure 7.

According to the pressing of palm oil at a speed of 133 rpm at 3 periods of time, 15 min provided the highest efficiency of pressing palm oil at 26.90% shown in Figure 8.

According to the pressing of palm oil at a speed of 155 rpm at 3 periods of time, 15 min provided the highest efficiency of pressing palm oil at 36.51% shown in Figure 9.

According to the pressing of palm oil with 3 levels of speed, a speed of 155 rpm before dried with hot air at 73 degree Celsius [27], [28] provided the highest efficiency in pressing palm oil.

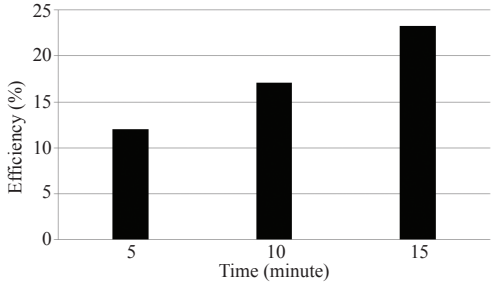

Figure 7: The efficiency of pressing palm at a speed of 110 rpm before dried with hot air.

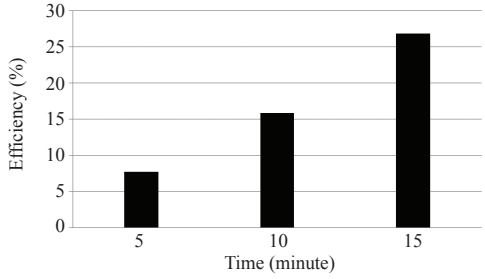

Figure 8: The efficiency of pressing palm at a speed of 133 rpm before dried with hot air.

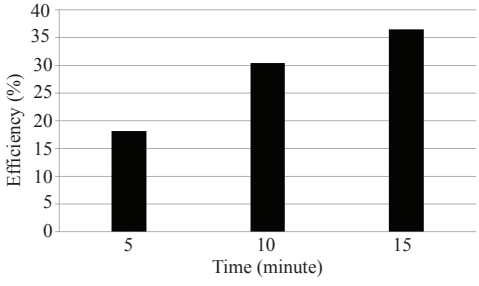

Figure 9: The efficiency of pressing palm at a speed of 155 rpm before dried with hot air.

4.2.2 Results and analysis of the results of the experiment after dried with hot air

The results revealed that for the operation of palm oil pressing machine at a speed of 110 rpm at 5 min after dried with hot air, little amount of palm oil was obtained while the palm meat were left a lot as shown in Table 7.

According to the operation of palm oil pressing machine at a speed of 110 rpm at 10 min, palm oil was obtained more than that of at 5 min, but there was some palm meat left shown in Table 7.

According to the operation of palm oil pressing machine at a speed of 110 rpm at 15 min, it provided the highest amount of palm oil at the speed of 110 rpm there was no palm meat left shown in Table 7.

Table 7: Palm oil obtained at a speed of 110 rpm at 5, 10, 15 min after dried with hot air

Time	Palm Oil	Palm Meat
5 min		
10 min		N/A
15 min		N/A

The results of the operation of palm oil pressing machine revealed that at a speed of around 133 rpm at 5 min after dried with hot air, little amount of palm was obtained and little amount of palm meat was left shown in Table 8.

According to the operation of palm oil pressing machine at a speed of 133 rpm at 10 min, palm oil was obtained more than that of at 5 min and there was no palm meat left shown in Table 8.

According to the operation of palm oil pressing machine at a speed of 133 rpm at 15 min, it provided the highest amount of palm oil at the speed of 133 rpm and there was no palm meat left shown in Table 8.

The results of the operation of palm oil pressing machine revealed that at a speed of around 155 rpm at 5 min after dried with hot air, little amount of palm oil was obtained and little amount of palm meat was left shown in Table 9.

According to the operation of palm oil pressing machine at a speed of 155 rpm at 10 min before dried with hot air, palm oil was obtained more than that of at 5 min and there was no palm meat left shown in Table 9.

According to the operation of palm oil pressing machine at a speed of 155 rpm at 15 min, it provided the highest amount of palm oil at the speed of 155 rpm and there was no palm meat left shown in Table 9.

Table 8: Palm oil obtained at a speed of 133 rpm at 5, 10, 15 min after dried with hot air

Time	Palm Oil	Palm Meat
5 min		
10 min		N/A
15 min		N/A

Table 9: Palm oil obtained at a speed of 155 rpm at 5, 10, 15 min after dried with hot air

Time	Palm Oil	Palm Meat
5 min		
10 min		N/A
15 min		N/A

According to the operation of palm oil pressing machine at a speed of 110 rpm after dried with hot air using 1 kg of palm meat for 5, 10, and 15 min, respectively, the amount of palm oil obtained was 105.3, 236.14, and 270.94 g, respectively. The efficiency of the operation was 10.50, 23.61, and 27.09%, respectively. The average was 20.40%. The efficiency and average of the

data calculated following the Equations (2) and (6), respectively. From the operation of palm oil pressing machine at a speed of 133 rpm after dried with hot air using 1 kg of palm meat for 5, 10, and 15 min, respectively, the amount of palm oil obtained was 60.71, 104.29, and 156.12 g, respectively. The efficiency of the operation was 6.07, 10.43, and 15.61%, respectively. The average was 10.70%. The efficiency and average of the data calculated following the Equations (2) and (6), respectively. For the operation of palm oil pressing machine at a speed of 155 rpm before dried with hot air using 1 kg of palm meat for 5, 10, and 15 min, respectively, the amount of palm oil obtained was 55.99, 99.71, and 137.73 g, respectively. The efficiency of the operation was 5.60, 9.97, and 13.77%, respectively. The average was 9.78%. The efficiency and average of the data calculated following the Equations (2) and (6), respectively and shown in Table 10.

Table 10: The results of pressing palm oil after dried with hot air

Speed (rpm)	Time (minute)	Weigh of Palm (g)	Weight of Palm after Pressing (g)	Efficiency (%)
110	5	105.03	48.42	10.50
	10	236.14	N/A	23.61
	15	270.94	N/A	27.09
133	5	60.71	70.30	6.07
	10	104.29	N/A	10.43
	15	156.12	N/A	15.61
155	5	55.99	79.01	5.60
	10	99.71	N/A	9.97
	15	137.73	N/A	13.77

According to the pressing of palm oil at a speed of 110 rpm at 3 periods of time, 15 min provided the highest efficiency of pressing palm oil at 27.09% shown in Figure 10.

According to the pressing of palm oil at a speed of 133 rpm at 3 periods of time, 15 min provided the highest efficiency of pressing palm oil at 15.61% shown in Figure 11.

According to the pressing of palm oil at a speed of 155 rpm at 3 periods of time, 15 min provided the highest efficiency of pressing palm oil at 13.77% shown in Figure 12.

According to the pressing of palm oil with 3 levels of speed, at a speed of 110 rpm at 15 min after dried with hot air, it provided the highest efficiency in pressing palm oil.

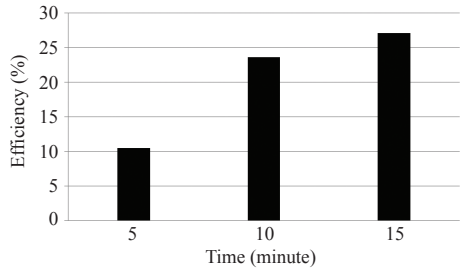

Figure 10: The efficiency of pressing palm at a speed of 110 rpm after dried with hot air.

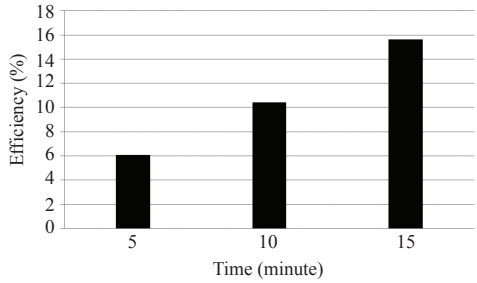

Figure 11: The efficiency of pressing palm at a speed of 133 rpm after dried with hot air.

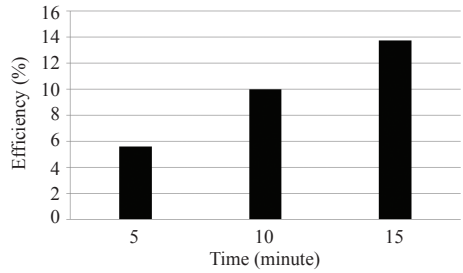

Figure 12: The efficiency of pressing palm at a speed of 155 rpm after dried with hot air.

Table 11 presented the comparison of the results of the experiment of palm oil pressing machine before and after dried with hot air. It can be seen that before dried with hot air, the most effective operation of pressing palm oil was at a speed of 155 rpm at 15 min, which 365.05 g of palm oil was obtained. After dried with hot air, the most effective operation of pressing palm oil was at a speed of 110 rpm at 15 min, which 270.94 g of palm oil was obtained. It was obvious that after dried with hot air, using the slow speed with a long period of time to press palm provide

higher amount of palm oil than those of faster speed because the palm meat after dried with hot air was soft. Therefore, pressing it at high speed would make palm meat become mud that screw compressor cannot convey all of palm meat for pressing.

Table 11: The comparison of the results of pressing palm oil before and after dried with hot air

Speed (rpm)	Time (minute)	Weigh of Palm (g)		Weight of Palm after Pressing (g)	
		before	after	before	after
110	5	120.17	105.03	133.28	48.42
	10	171.28	236.14	197.63	N/A
	15	233.06	270.94	N/A	N/A
133	5	76.78	40.71	110.00	70.30
	10	118.48	104.29	N/A	N/A
	15	268.99	156.12	N/A	N/A
155	5	181.80	95.99	N/A	79.01
	10	344.30	99.71	N/A	N/A
	15	365.05	137.73	N/A	N/A

4.2.3 Results of the electricity consumption analysis

The results showed that palm oil pressing machine could press 4 kilograms of palm oil per hour. The electricity consumption was 0.86 kWh. It can work continuously without stopping the machine. The machine can run 8 hours a day which 32 kilograms of palm oil a day can be produced. The electricity consumption rate was 9.6 kW/day. The electricity charge per month was 1,152 baht per month.

5 Conclusions

The palm seed separating machine took 35 s for separating 1 kg of palm oil at 483, 725, and 967 rpm. In addition, the speed of 483 rpm provided the best efficiency. The efficiency of separating seeds was 91.76%. For the palm oil pressing machine, the results of the experiment before dried with hot air and after dried with hot at the speed of 110, 113, and 155 rpm and each round took 3 times which were 5, 10, and 15 min revealed that the best speed of palm oil pressing machine pressing palm meat before dried with hot air was 155 rpm. The efficiency of pressing was 36.51%. Also, the best speed of palm oil pressing machine pressing palm meat after dried with hot air was 110 rpm. The efficiency of pressing palm oil was 27.09%.

Recommendations

1. The bigger machine is recommended for being used in the real operation in order to increase the efficiency in pressing palm oil.

2. Pitch and inclination of the spiral should be increased because the pitch which is not enough and the inclination of the spiral with inappropriate degree cannot convey all palm scrap out.

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