Progressive Agriculture 30 (3): 317-327, 2019 ISSN: 1017 - 8139

Progressive Agriculture
Journal homepage:http://www.banglajol.info/index.php/PA

Performance evaluation of a motor operated oil palm crusher

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Abstract

Performance of a motor operated oil palm crusher was tested at the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh. The crusher is powered by a three- phase 7.5hp electric motor. Crushing efficiency and crushing capacity are some of the most important parameters for evaluating the crushing performance. This study provides some information on the composition of crude palm oil, palm oil extraction methods, the crushing efficiency, etc. The crusher has an average oil extraction efficiency of 72.84 %. This was obtained from 2.5kg of palm fruit at the steaming time of 2min. The average crushing capacity of the crusher was 12.72 kg/hr. The average crude palm oil percentage in fruit was 19.67%. On an average 200 gm of crude palm oil was extracted from 1 kg of fruit. The average oil cake percentage in palm fruit was 62.2% and the average sediment percentage was 14.04%. Manually, the crushing capacity was 0.84 kg/hr, crude palm oil percentage was 22.14%, oil cake percentage was 44.28%. The break-even point of the crusher was 700 hr. It means that if the crusher is used for more than 700 hr, it will be economically suitable compared to manual crusher. The quality parameters evaluated were Free fatty acid, Iodine value, Peroxide value and Saponification value. Free fatty acid was 1.33%; Iodine value was 50; Peroxide value was 2meq/kg; and Saponification value was 120. Overall performance of the machine was satisfactory compared to manually operated crusher.

Key words: Performance test, design, oil pump, crusher

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Introduction

The oil palm tree *(Elaeis guineensis)* is a perennial plant which is indigenous to tropical areas. It produces more oil per hectare than any of the oil producing crops. The primary products of the oil palm are palm oil (from the mesocarp) and palm kernel oil (from the kernels (seeds). Palm oil accounts for about 13% of the total world production of oils and fats, and is expected to overtake soybean oil as the most important vegetable oil (Sundram *et al.,* 2003). The best quality of crude palm oil quality must have FFA percentage of less than 5% whereas the moisture content is less than 0.1% and the percentage of dirt is not more than 0.01%. The highly rated commercial oil palm fruit is type Tenera, a hybrid of Durra and Pisifera (Baryeh, 2001 and Sundram *et al.,* 2003). Tenera has a shell of less than 3mm thick 60-96% mesocarp, 3-20% shell and 3-15% kernel making it tenable to high extraction yield. Vegetable oil consumption is increasing compared to animal fat due to its health implication. In 2007, the value of world trade in oilseeds and oilseed products was estimated to be 83 billion dollars;

equivalent to 13% of the total agricultural trade and it was the third most valuable component in total world agricultural trade, next to meat and cereals (Ndukwu and Asoegwu, 2010). Therefore, high yields of the oil palm throughout the year are essential to meeting the high global expert market demand. Bangladesh is deficit in oils and fats since long. It produces only 10 percent of its requirement. At present, annual requirement of oil and fats in Bangladesh is about 1.76 million tons. Against this requirement, the local production of oils and fats has remained below 200,000 tons (Alam and Fakhru, 2013). In 2015-2016, 23 lakh ton oil was consumed in Bangladesh and to fulfill the requirement 20.4 lakh ton of oil had to imported (USDA, 2017). For increased demand the cultivation of palm is increasing in Bangladesh. About 10 lakhs of oil palm tree are planted in various region. Maximum palm trees are started flowering and bears huge fruit branches every year. Growers are facing problems with processing of these fruit. Due to lack of processing every year lots of fruits are wasted. So, it is necessary to supply a crusher and evaluate the performance of the crusher.

Adeniyi *et al.,* (2014) found that 35.3 % of the manual processors, 36.1 % of the semi-mechanized processors and 85.7 % of the fully mechanized processors produce palm oil of Grade A quality respectively and fully mechanized method given the best quality. Ismail *et al.,* (2015) developed an improved palm kernel shelling and sorting machine. The machine optimum shelling-sorting efficiency was found to be 90 percent, throughput capacity was 59kg/h, and whole kernel recovery was 70 %, low costs of production and maintenance. Islam (2015) designed and developed a manually operated oil palm crusher at the workshop of farm power & machinery department, BAU. crushing capacity, rotating speed, crude oil percentage, oil extraction efficiency was respectively 0.84 kg/hr, 26 rpm, 22.14%, 82%. The weight of the crusher was 11kg. The Food and Agriculture Organization (FAO, 2002) of the United Nations compiled a bulletin that described method of palm oil processing. According to the bulletin, often small- scale facilities, which process two or less tonnes of fresh fruit bunch per hour, employ batch processes that utilize manual labor and had low operating costs. Large-scale facilities typically use continuous systems and required skilled labors and greater management. Large- scale plants process more than ten and often up to sixty tonnes of fresh fruit bunches per hour (Kwaski, 2002).

There are, however, no available records or published materials showing that the screw press has ever been evaluated or characterized. The objective of this study, therefore, was to evaluate the performance of a screw press with respect to its throughput capacity, feed rate, percentage of cake oil content, sediment percentage, percentage of crude oil yield, oil extraction efficiency, and oil quality so as to pronounce on the suitability and the need for any design improvements.

Materials and Methods

***Experimental Site*:** The experiment was conducted at the engineering workshop of the Department of Farm Power and Machinery, Bangladesh Agricultural University, Mymensingh.

***Physical properties of palm fruit*:** The dimension of palm fruit was measured with the help of slide calipers. The average length and breadth of palm fruit was (3.375 ± 0.55) cm and (2.67 ± 0.65) cm respectively. The weight of an individual palm fruit and palm kernel were measured with the help of electrical weighing balance (ENTRIS822-1S, 0.01g, Sartorius Lab Instruments GmbH & Co. KG, Germany). Weight of ten palm fruits with kernel were taken by electric weight machine. The average weight of palm fruit was 22.57 gm. The weight of palm fruit was varied from 17 to 26.94 gm. Weight of palm kernel varied from 8.7 to 12 gm. Average weight of palm kernel was 10.44 gm. To determine the moisture content, palm fruits were placed in the electric oven at 105 ^oC for 24 hrs (Razavi and Taghizadeh, 2005). After 24 hrs final weight was taken. By using following formula moisture content of palm fruit was determined.

Moisture content (wb) = {(W_1- W_2)/ W_1} * 100

Where, W_1 = Initial weight of palm fruit,

W_2 = Final weight of palm fruit.

The average moisture content was 20.73%.

***Different parts of the crusher*:** The crusher was designed and developed by Ahamad (2015). Photographic view of the oil palm crusher is shown in Figure 1.

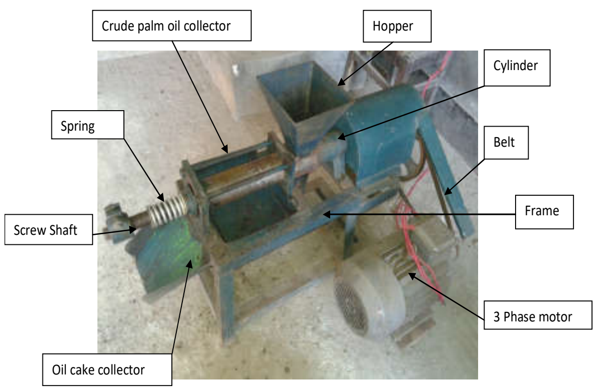

Figure 1. Photographic view of the crusher (Ahamad, 2015).

Cylinder: The cylinder was constructed with mild steel. Outside diameter of cylinder was 85 mm and inside diameter was 68 mm. The length of cylinder was 254 mm.

Hopper: Hopper was constructed with mild steel. It is the most important part for designing and developing of the crusher. The shape of the hopper was square. Feeding diameter of hopper was 63 mm.

Barrel: Barrel was constructed using mild steel. The length of the barrel was 279.4 mm. outside diameter of barrel was 85 mm and inside diameter was 68 mm.

Pulley: It was made of cast iron (CI). Diameter of pulley was 254 mm. It was adjusted to gear box. Whole diameter of pulley was 28 mm.

Gear and pinion: Among the gears, the largest one is gear, and the smallest one is pinion. These were made of carbon steel (CS). Number of teeth in gear was 45 and in pinion were 12.

Idle shaft and line shaft: Idle shaft was made of CS and Line shaft was made of CS. Two bearing (UCP206) were connected with idle shaft.

Screw shaft: The screw shaft was constructed with mild steel. The length of the screw shaft was 939.8 mm. The length of helical screw portion was 533.4 mm. The diameter of helical screw shaft was 66 mm. The length of small helical screw portion was 203.2 mm and diameter of small shaft was 38mm.

Jamnut and pressure cone: Jamnut and pressure cone was constructed using mild steel. Outside diameter of jamnut was 63 mm and inside diameter was 35 mm. The length of the jamnut was 60 mm. The outside diameter of pressure cone was 90 mm and inside diameter was 38 mm.

Spring: Spring was constructed with CS. Diameter of spring was 62mm and the length of spring was 110 mm.

Frame: Frame was consist of mild steel (MS). Crusher was mounted on frame.

Specification of the machine: Specification of the crusher is shown in Table 1. The construction was easy and simple.

***Working principle*:** In operation, the steamed palm fruit was introduced into the machine through the feeding hopper; the machine convey presses the palm fruit inside the cylindrical barrel with the aid of the worm shaft until crude oil is pressed out of the mash. The crude oil extracted was drained through the oil channel into the oil tray where it was collected. The residual cake is discharged at the cake outlet and collected at the cake tray. The machine was powered by a 7.5hp three – phase electric motor with the construction materials being locally available at affordable costs. Flow diagram of unit operations in palm oil processing by motor operated crusher is given in Figure 2.

Table 1. Details of the oil palm crusher

Particulars	Description
Name	Motor operated oil palm crusher
Source of power	Electric motor (7.5 hp and 1440 rpm)
Source of power for driving	V-belt and pulley and by gear
Weight of the machine	70kg
No. of cylinder	One
No. of Barrel	Two
Spring	One
Pressure cone	Four
Bearing	UCP206 and Ball
No. of hopper	One
No. of operator	One
Feeding system	Rotating screw shaft
Crushing mechanism	Rotation of screw shaft developed high pressure
Recommended speed	40 rpm
Crushing capacity	12.72kg/hr

***Collection of Fresh Fruit Bunch (FFB)*:** The palm oil production process started after the FFB were harvested. After harvesting, it is important to process fresh fruit bunches as soon as possible to prevent rapid rise in free fatty acids, which could adversely affect the quality of the crude palm oil. FFB were harvested using chisels. These fruit bunches (each bunch weighing about 3 kg) were then collected and FFB were weighed accordingly.

***Selection of fresh ripen fruit*:** Matured fruits were collected on the basis of odor, size and color. The unripe fruit contains very little oil but the mesocarp of ripe fruits has an oil content of 70-75 % of its total weight. Palm oil has a balanced ratio of saturated and unsaturated fatty acids.

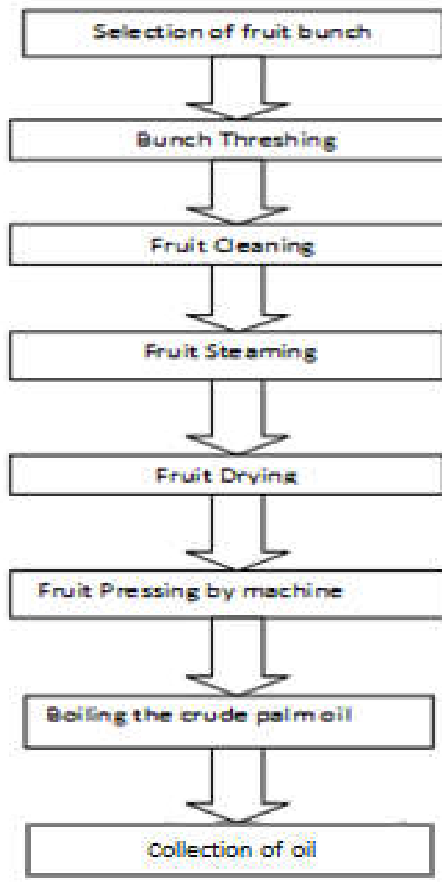

Figure 2. Unit operations in palm oil processing by motor operated crusher.

***Separation of fresh fruit from bunch*:** The FFB consists of fruits embedded in spikelets growing on a main stem. Manual threshing is achieved by cutting the fruit-laden spikelets from the bunch stem with an axe and then separating the fruits from the spikelets by hand. Fresh fruits were separated from the bunch carefully.

***Cleaning the fruits*:** After separation, the fruits were cleaned with water to remove the foreign materials from the fruits.

Weighed the fruit**:** The palm fruits were weighed for streaming with the help of weighing machine.

Steaming of palm fruits**:** Steaming typically destroys oil-splitting enzymes and arrests hydrolysis and auto oxidation, weakens the fruit stem and makes it easy to remove the fruits from bunches, helps to solidify proteins in which the oil-bearing cells are microscopically dispersed, weakens the pulp structure, softening it and making it easier to detach the fibrous material. It prevents free fatty acid build up in the oil. Steaming was performed for two to five minutes. Some moisture was removed through streaming in the pan.

Drying the fruits**:** After weighing, the fruits were kept in open air for one hour to remove the extra water from the palm fruits.

Weighing of steam fruit**:** The palm fruits were again weighed. Some weight was lost for moisture loss during steaming.

Pressing the fruit by machine to extract crude palm oil**:** To extract crude oil, the fruits were poured into the hopper of the machine and pressed (Figure 3) to separate oil from fiber and seeds. Then crude palm oil was collected.

(a) Crude palm oil with scum

(b) Oil cake

Figure 3. Extraction of crude palm oil.

Boiling of crude palm oil**:** After extracting, the crude oil with scum was boiled for five minutes. Then it was kept still for a few minutes to extract the crude oil and separate the scum as shown in Figure 4.

(a) Crude oil

(b) scum

Figure 4. Boiling of crude palm oil with scum to separate crude oil.

Performance of the oil palm crusher

***Determination of crushing capacity (kg/min) of the motor driven oil palm crusher*:** The amount of palm fruits were weighed by electrical weight machine and required time for crushing the fruits was recorded by stopwatch.

So, the crushing capacity = $\frac{W}{T}$ kg/min……………(2)

Where, W = Weight of fruits (kg)
T = Total crushing time, min

Determination of crude palm oil percentage in fruits mesocarp: Before crushing, palm fruits were weighed. And after crushing, the amount of crude oil from fruits were also weighed.

So, Crude palm oil percentage, % = $\frac{W1}{W} \times 100$…......(3)

Where, W_1= Weight of crude palm oil (kg)

***Determination of oil cake percentage in fruit*:** The amount of oil cake was weighed and the amount of fruit was weighed before crushing.

Oil cake percentage = $\frac{W2}{W} \times 100$…………………(4)

Where, W_2 = Weight of oil cake (kg)

***Determination of scum percentage in fruit*:** Scum was collected after crushing and weighed.

So, the scum percentage = $\frac{W3}{W} \times 100$………………(5)

Where, W_3 = weight of scum, kg

***Determination of oil extraction efficiency of the crusher*:** The standard crude oil percentage of oil palm is 26-27 % (FAO, 2002). For calculating oil extraction efficiency, CPO percentage obtained by the motor operated oil palm crusher is divided by this standard value.

Oil extraction efficiency= $\frac{\text{Determined oil extraction as in (b)\%}}{\text{oil expected \% (Standard value)}}$ ..(6)

***Cost analysis*:** The total cost of the machine was determined by depreciation, fabricating cost, labor cost, R & M, interest on investment of the machine.

***Annual cost*:** The annual cost (Operating cost) of the machine was determined by using the following equation:

Operating cost, AC= Fixed cost + Variable cost…..(7)

***Fixed cost*:** It is the total cost of depreciation, interest on investment, tax, insurance, and shelter. Straight-line method was used, for calculating the depreciation of the machine.

Annual depreciation, D = $\frac{(P-S)}{L}$………………………(8)

Where, D = Depreciation, Tk/Yr; P = Purchase price, Tk; S = Salvage value, Tk; L = Life of machine, Yrs.

Interest on investment, I= $\frac{(P+S)}{2} \times i$………………….(9)

Where, i= Rate of interest.

***Variable cost*:** It is the total cost of labor, repair & maintenance and electrical energy cost on investment.

Variable cost = L+R & M+E………………………(10)

Where, L=Labor cost, Tk/hr; E=Electrical Energy cost, Tk/hr; R & M= Repair and Maintenance cost, Tk/hr.

***Break-even point analysis*:** The break-even point for machine was calculated by determining annual cost & comparing it with manually operated crushing machine.

Determination of quality parameters of crude palm oil: The quality of crude palm oil can vary widely depending upon the processing technique. The present work was undertaken to evaluate some quality parameters of crude palm oil. The experiment was conducted at the lab of Food Technology & Rural Industries, BAU. The parameters evaluated were free fatty acid (FFA), Iodine value (IV), Peroxide value (PV), Saponification value.

Determination of acid value: The acid value is defined as the number of milligrams of potassium hydroxide required to neutralize the free fatty acids present in one gram of fat (FSSAI, 2015).

Free fatty acids as oleic acid= $\frac{28.2\ VN}{Wo}$ % by weight…(11)

Acid value = Percent fatty acid (as oleic) x 1.99

Where, V=Volume in ml of standard potassium hydroxide or sodium hydroxide used; N=Normality of the potassium hydroxide solution or Sodium hydroxide solution; W_o = Weight in g of the sample.

Determination of iodine value: The iodine value of an oil/fat is the number of grams of iodine absorbed by 100g of the oil/fat, was determined by using Wijs solution (FSSAI, 2015).

Iodine value = $\frac{12.69\ (B\text{-}S)N}{Wo}$……………………….(12)

Where, B=volume in ml of standard sodium thiosulphate solution required for the blank; S=volume in ml of standard sodium thiosulphate solution required for the sample; N=normality of the standard sodium thiosulphate solution.

Determination of peroxide value: The peroxide value of oil is the amount of peroxide present and expressed as milli-equivalents of peroxide per 1000gm of sample (FSSAI, 2015).

Peroxide value = $\frac{(S\text{-}B)\times N\times 1000}{Wo}$……………………(13)

Where, B=Volume in ml of standard sodium thiosulphate solution required for the blank; S=Volume in ml of standard sodium thiosulphate solution required for the sample; N=Normality of the standard sodium thiosulphate solution.

Determination of saponification value: The saponification value is the number of mg of potassium hydroxide required to saponify 1 gram of oil/fat. The oil sample was saponified by refluxing with a known excess of alcoholic potassium hydroxide solution. The alkali required for saponification was determined by titration of the excess potassium hydroxide with standard hydrochloric acid (FSSAI, 2015).

Saponification value = $\frac{56.1(B\text{-}S)N}{Wo}$………………..(14)

Where, B=Volume in ml of standard hydrochloric acid required for the blank; S=Volume in ml of standard hydrochloric acid required for the sample; N=Normality of the standard hydrochloric acid

Results and Discussion

Amount of crude palm oil, scum, oil cake: Amount of crude palm oil, oil cake, scum were collected from fruits are shown in Table 2.

Amount of crude palm oil, scum, oil cake percentage: The crushing operation was done for 10 min. In treatment 1,2,3,4,5,6,7 and 8, the crude oil production was too little for huge time steaming and unripe fruit. The unripe fruits contain very little oil but the mesocarp of ripe fruits has an oil content of 70–75% of its total weight. Hence, crude palm oil percentage, scum percentage, and oil cake percentage was not determined. The crushing capacity of the machine, amount of Crude palm oil percentage, oil cake percentage, scum percentage were determined as shown in Table 3.

Crushing capacity of the crusher (kg/min): The highest crushing capacity was found 0.290 kg/min and lowest was 0.18 kg/min. The average crushing capacity was 0.212 kg/min. So, crushing capacity was 12.72 kg/hr. In manual crusher, crushing capacity was 0.84 kg/hr (Islam, 2015).

So, crushing capacity of motor operated crusher is 15 times higher than manual crusher.

***Crude palm oil percentage in fruit*:** The highest crude palm oil percentage in fruit was 23.04 and lowest was 15.38. The average crude palm oil percentage in fruit was 19.67. In manual crusher, crude palm oil percentage in mesocarp of fruit was 22.14% (Islam, 2015). Here, mesocarp was separated from fruit and large amount of fruit was required than power operated crusher and amount of mesocarp was taken for calculation rather than amount of fruit. The standard crude oil percentage of oil palm is 26-27% (FAO, 2002).

Table 2. Amount of crude palm oil, scum, oil cake.

Treatment	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}	T_{13}
Steaming time (min)	25	50	40	10	10	5	5	5	2	2	2	2	Without steaming
Fresh fruit (kg)	2.20	2.00	2.50	2.00	2.00	2.00	2.00	2.00	6.00	2.36	2.50	2.00	2.00
After steaming fruit weight (kg)	2.14	1.90	2.40	1.99	1.95	1.85	1.84	1.95	5.80	2.30	2.45	2.00	1.95
Oil cake (kg)	1.30	1.20	1.60	1.56	1.34	1.50	1.46	1.32	3.79	1.27	1.66	1.12	1.30
Scum/sediment (kg)	0.71	0.62	0.75	0.30	0.53	0.24	0.26	0.56	0.61	0.37	0.34	0.39	0.20
Crude palm oil (kg)	0.03	_	_	0.02	0.01	0.02	0.02	0.03	1.20	0.53	0.41	0.45	0.30
Loss (kg)	0.10	0.08	0.05	0.10	0.07	0.090	0.10	0.04	0.20	0.13	0.04	0.04	0.15

Table 3. Amount of crude palm oil percentage, scum percentage, oil cake percentage.

Treatment	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}	T_{13}
Crushing time (min)	10	10	10	10	10	10	10	10	10	10	10	10	10
Crushing capacity (kg/min)	0.21	0.19	0.24	0.19	0.19	0.18	0.18	0.19	0.29	0.23	0.22	0.2	0.19
Crude palm oil %									20.69	23.04	16.73	22.5	15.38
Crude palm oil per kg of fruit									0.21	0.23	0.18	0.23	0.15
Oil cake %									65.34	55.22	67.76	56	66.67
Scum %									10.52	16.09	13.88	19.5	10.25
Oil extraction efficiency %									76.63	85.33	61.96	83.33	56.96

***Amount of crude palm oil per kg of fruit*:** The highest amount of crude palm oil per kg of fruit was 0.23 kg and lowest was 0.15 kg. The average crude palm oil per kg of fruit was 0.20 kg. In manual crusher it was 0.221 kg from 1 kg mesocarp (Islam, 2015).

***Oil cake percentage in fruit*:** The highest oil cake percentage was 67.76% and lowest was 55.22%. The average oil cake percentage in fruit was 62.2%. In manual machine, it was 44.28 % in mesocarp (Islam, 2015).

***Sediment /scum percentage in fruit*:** The highest sediment percentage in fruit was 19.5% and lowest was 10.25%. The average sediment percentage in fruit was 14.04%. In manual it was 31.42% (Islam, 2015). It was because, in manually oil was extracted only from fruit mesocarp.

***Oil extraction efficiency of the crusher*:** The highest oil extraction efficiency was found 85.33% and lowest was 56.96%. The average oil extraction efficiency of the crusher was 72.84 %. In manual crusher oil extraction efficiency was 82% (Islam, 2015). It was because, in calculation the amount of fruit was not calculated, the amount of mesocarp was taken for calculation.

***Operating cost of the machine*:** The manufacturing cost of the crusher was 44,500 tk. Total operating cost and annual cost were shown in Table 4.

Table 4. Operational cost and annual cost of the crusher.

Cost item	Amount
Fixed cost (Tk/yr)	10,858
Total operating cost (Tk/yr)	149768
Total operating cost for manually operated crusher (Tk/yr)	159489

***Break-even analysis*:** From Figure 5, it can be observed that the break even point is 700 hr. It means that if the machine is used more than 700 hr, it will be economically suitable. Crushing capacity of the machine is 12.72 kg/hr. So, if 8904 kg fruit is crushed in a yr, it will also be suitable. Assume that, weekly working hour is 30 hrs. So, 164 days or 5.5 months will require to reach the break-even point.

Quality parameters of crude palm oil: Palm oil has the color of a rich, deep red which is said to be derived from its rich carotenoid contents. The parameters evaluated were: Free fatty acid (FFA): 1.33, Iodine Value (IV): 50, peroxide value (PV): 2 meq/kg, saponification value: 120. In palm oil FFA ranged between 1.06- 2.9%; IV: 48-53; PV: 2.93-10.02 and SPV: 190-205 (Sarwar *et al.,* 2016 and Orsavova *et al.,* 2015). The obtained value varies with expected range because the oil was crude and was not refined.

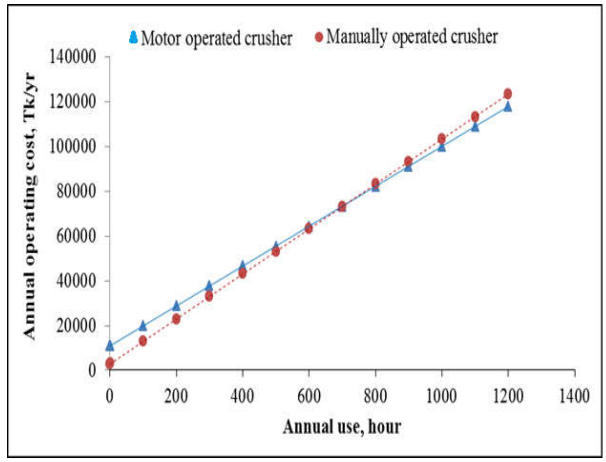

Figure 5. Break-even point of the motor operated crusher compare to manually operated crusher.

Among palm oil, palm kernel oil, soybean oil, coconut oil, sunflower oil, mustard oil, castor oil, olive oil, rice bran oil and ground nut oil, the highest value of IV in soybean oil (130) and lowest in coconut oil (10); the highest value of PV in soybean oil (3.19) and lowest in palm kernel oil (0.3); the highest range of saponification value in coconut oil (250-265) and lowest in soybean (180-200) (Table 5).

Table 5. Palm oils quality parameter.

Parameter	Sample			Average
	1	2	3	
FFA %	1.32	1.33	1.34	1.33
IV	50.1	49.5	50.4	50
PV (meq/kg)	1.93	1.97	2.1	2
Saponification value	119	120	121	120

Palm oil is unique among vegetable oils because of its high saturated acid content with a significant amount (10-16%) of saturated acid. Palm oil also contains appreciable amounts of free fatty acids, which can have a substantial effect on its physical properties.

The average peroxide value was 2 meq/kg and Frank *et al.,* (2013) found 4.34 meq/kg. The average free fatty acid value was 1.33% and Frank *et al.,* (2013) found 10.28%-0.64%. The result is near to the result of palm oil. But it is not suitable for eating. Boiling is not enough for using and marketing. The red palm oil is acceptable for consumption without further processing other than simple filtering or settling operation to remove solid impurities.

Conclusions

A motor operated oil palm crusher was tested for palm oil extraction from fresh fruit bunch. The crusher was simple enough for local fabrication, operation, repair and maintenance. The weight of the crusher is 70 kg which is easy to carry. It is powered by a three- phase 7.5 hp electric motor. The crusher has an average oil extraction efficiency of 72.84 % from palm fruit. That was obtained from 2.5 kg of fruit at the steaming time of 2min. The average crushing capacity of the crusher was 12.72 kg/hr. The average crude palm oil percentage in fruit was 19.67. The average crude palm oil per kg of fruit was 0.20 kg. That means 200 gm crude palm oil extracted from 1 kg of fruit. The average oil cake percentage in fruit was 62.2 and the average sediment percentage was 14.04.

The break even point of the crusher is 700 hr. It means that if the machine is used more than 700 hr, it will be economic. Crushing capacity of the machine is 12.72 kg/hr. So, If 8904 kg fruit is crushed in a yr,it will also be economic. The quality parameters evaluated were Free fatty acid, Iodine value, Peroxide value and Saponification value. Free fatty acid was 1.33; Iodine value was 50; Peroxide value was 2meq/kg; and Saponification value was 120. A palm fruit oil processing plant based on this technology can provide employment for at least two persons at the same time provide palm oil at affordable costs for rural and urban communities.The crusher can be used for small and medium scale palm fruit processors in order to mechanize the extraction process and increase production output. But some problem were found in crusher during crushing such as the hole of the cylinder was too small for oil extraction, the diameter of the feeding hopper was small for feeding, the shaft was sufficed out at the time of crushing and other small trouble observed in crusher during crushing.

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