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DEVELOPMENT OF MOTORIZED OIL PALM FRUIT ROTARY DIGESTER

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Abstract
A motorized oil palm fruit rotary digester comprising of a feed hopper, hammers, axle, screening plate, v-belt, 2hp electric motor, digesting chamber and frame was designed and developed using standard and locally sourced materials. The performance test analysis showed that its throughput capacity is 117.93kg/hr with a performance efficiency of 64.88% at an optimum operational speed of 621.4rpm. Rate of digestion increased with the mass of the digesting palm fruit while the efficiency of the oil palm fruit digesting machine decreased with increase in mass of the digesting palm fruit in some cases.

Keywords: Digester, Oil palm fruit, Extraction, Dura, Tenera, Pisifera.

1. Introduction

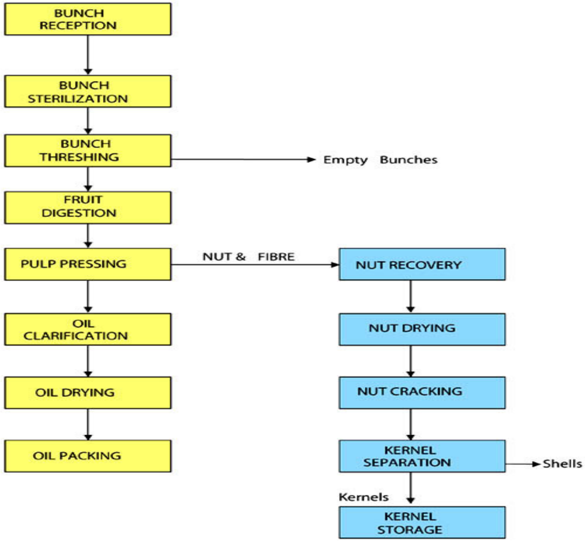
Oil palm is a valuable crop because of its major products (red palm oil and white palm kernel oil). Palm oil is of considerable commercial importance. About 14% of world's supply of vegetable oil is derived from oil palm [1]. The extraction of vegetables and edible oil seeds such as groundnuts, kernels, copra, palm fruit etc, is a well-established industrial activity in a number of developing West African and Asian countries like Senegal, Liberia, Cameroon, Sierra Leone, Nigeria, Malaysia and Indonesia. Nigeria used to be one of the highest producers of palm fruit until the discovery in 1958 of crude oil in the southern part of the country [2]. This diverted attention from agricultural production, which used to be the main stay of the economy [3].

The oil palm, (Elaeis guineensis) belongs to the family of Palmae and is a major tropical tree crop in Nigeria. It is grown in the Southern part of the country and the Guinea savannah area of the Middle belt. It originated from the tropical rain forest region of West Africa with its main oil palm belt running through the Southern latitudes of Sierra Leone, Liberia, Ivory Coast, Ghana, Togo, Benin, Nigeria, Cameroon and into the equatorial region of Zaire and Angola between latitudes 10°N and 10°S [4]. The oil palm is an erect single stemmed tree of fairly uniform column growing up to eight meters or more at maturity. The ovary inflorescence develops large bunches and each bunch contains approximately between 800-1000 fruits [5]. The size of the fruits or the nuts depends mainly on the thickness of the shell. Because of its economics importance as a high-yielding source of edible oils, oil palm is now grown as a plantation crop in most countries with high rainfall (minimum 1600mm/year). The palm bears its fruits in bunches varying in weight from 10 to 40kg. The individual fruits are made up of an outer skin (exocarp), a pulpy skin (mesocarp) containing the palm oil in fibrous matrix, central nut consisting of shell carp) and the kernel which itself contains oil quite different from palm oil. The fruit is an oval-shaped drupe *2.5*- 5cm in length and *2.5cm* in diameter. The fruits are borne tightly clustered in large bunches which may weight from 5kg in young pour palms to as much as 40kg in 15-year-old palms in favourable condition [5]. Three types/varieties of palm fruit exist [4]: the dura, pisfera and tenera. The dura consists of a thick pericarp or exocarp, 2–8 mm thick, a thin mesocarp (which is responsible for the low palm oil content of this variety), thick endocarp (shell) and generally large kernels (which make it suitable for kernel oil production). Its mesocarp content is 35–55%. The pisfera has fruits which possesses thick mesocarp (with very little oil content), no endocarp (shell less) and with small kernel. The tenera type possesses thick mesocarp (much pulp), thin endocarp and a reasonably sized kernel. It is the product of the cross of pisfera and dura. It is useful in the production of mesocarp oil but less kernel oil when compared with the dura variety. It is now commonly used as a planting material because of its superior yield of palm oil. The oil content of palm fruit depends on the thickness of the mesocarp (for palm oil) and the size of the kernel (for kernel oil)

The major producers of oil palm are the republic of Sierra Leone, Cameroon, Angola, Congo, Malaysia and Indonesia. Nigeria used to be a leading palm oil producer in the world. The wild oil palm groove in Nigeria is estimated at 2.1 million hectares whereas plantation estates and small holdings account for

81,475 and 105,184 ha, respectively. Red palm oil, the most important product of the oil palm, is the world's main edible oil also used for soap making [6]. It is used for soup and table fats such as margarine and for the production of cosmetics in many countries as well as useful raw material in pharmaceutical industries for the manufacture of drugs. Red palm oil is used in the manufacturing of soap, toiletries, surface active ingredients, baking coatings, whipped creams and sugar confectioneries. The meal obtained after oil extraction from the palm kernel nut is also used as animal feed. High quality palm oil is needed for domestic and industrial applications. Two types of oil are produced from the oil palm, red palm oil from the fruit white oil from the kernel. The palm oil content of the fruit is about *55%* and of the kernel is about 47% [7]. The fatty acid composition of the palm oil is very different from that of the palm kernel oil. Typically, for tenera fruit, 100 tones of fresh fruit bunches will yield 21 tonnes of oil and 6 tonnes of decorticated palm kernel oil. This palm kernel oil represents 12% of total oil production.

Figure 1 below shows the block diagram of the processes in oil palm production.



Source: [5]

Figure 1: Block diagram showing major stages involved in oil palm production

From the above block diagram, the key process in the oil palm production process is fruit pulping/digestion. Fruit pulping/digestion, which is taken as the fifth step in the block diagram above, involves the digesting of the boiled or unboiled mass of palm fruit in such a manner that its mesocarp (the fleshy part of the palm fruit) is separated from the kernel. This step is important in the sense that, it is only when the fruits have been thoroughly pulped that the various oil palm products like edible oil, soap, confectioneries etc can be derived. Figure 2 gives a cross sectional diagramme of oil palm fruit.

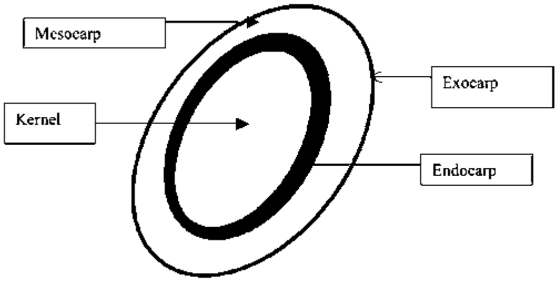


Figure 2: Fresh palm fruit

Digestion is the process of releasing the palm oil in the fruit through the rupture or breaking down of the oil-bearing cells. The digester commonly used consists of a steam-heated cylindrical vessel fitted with a central rotating shaft carrying a number of beater (stirring) arms. Through the action of the rotating beater arms the fruit is pounded. Pounding, or digesting the fruit at high temperature, helps to reduce the viscosity of the oil, destroys the fruits' outer covering (exocarp), and completes the disruption of the oil cells already begun in the sterilization phase. Unfortunately, for reasons related to cost and maintenance, most small-scale digesters do not have the heat insulation and steam injections that help to maintain their contents at elevated temperatures during this operation. Farmers and oil palm processors carry out the process of oil palm fruit digestion by manual means. Local, digestion of palm fruit is usually performed by the use of mortar and pestle or by barefoot processing method. In the mortar and pestle method, the boiled palm fruits are poured into the wooden mortar. The mortar is surrounded by villagers, mostly women, who take turns to pound/pulp the fruits using pestles. The amount or quality of palm fruits to be digested or pulped depends on the size of the mortar and the strength of the women. On the other hand, the barefoot processing method is quite similar to the mortar and pestle method, but in this case, the pulping chamber is a wooded canoe and the pestle is the bare foot. These primitive methods of digestions have a wide range of disadvantages, some of which are: slow and very low digestion and production rates, unhygienic, time-consuming, drudgery and the fact that a lot of human energy is usually expended during pulping/digestion. Due to this poor processing method, countries like Nigeria have not been able to fully utilize the product export capacity.

On the other hand, the mechanized form of palm oil processing which embodies to some extent the small and large scale mills may involve series of mechanized and automated system tending to serve the purpose of each major stage or process along the production line of which oil palm fruit digestion is one. Thus, one of the constrains in the mechanization and automation of small-scale palm oil mills is the unavailability of an efficient, small scale palm fruit digester of which this work chooses to address.

2. Materials and Method

2.1 Design Consideration and Specifications

Having studied the primitive method of digestion and mechanized rotary action oil palm fruit digester, a lot was taken into consideration in the development of the machine:

1. Higher capacity compared to the traditional /primitive method of palm fruit digestion.
2. Reduction in drudgery associated with the traditional/primitive method of palm fruit digestion.
3. Strength of material should withstand the force acting on the various components of the rotary palm fruit digester.
4. Simplicity and complexity of the digester should suit the intended user(s) and has no side effect on him and his environment.
5. The angle of inclination for the hopper was 45^o to the horizontal which was the angle of repose of the variety of palm fruit on stainless steel determined in the laboratory.

2.2 Machine Features

2.2.1 Hopper

The hopper is made up of 3.5mm gauge stainless steel sheet. The shape of the hopper is trapezoidal and also provides a doorway to the digesting chamber. The hopper is mounted on top of the digesting chamber and has a semi-circular shape at the throat region for easy flow of the palm fruit. The design is based on the angle of repose of 45^o of palm fruit on stainless steel which is determined for the dura, tenera and pisifera species.

2.2.2 Frame

The frame provides rigid and skeletal support for the entire system. Apart from the four-corner support of main frame work, it consists of two compartments, which are the support for the digesting chamber and another support for the electric motor. The frame is made of 2 inch angle iron bar. It has a length of 655mm, width 655mm and height of 400mm.

2.2.3 Digesting Chamber

This is set to provide housing for the hammers during operation. It is a cylindrical drum placed vertically with the top opening which a hopper was attached to serve as the door way to the digesting chamber. The bottom part is closed with a conical flange having a central opening of 25mm that will aid the collection of oil after digestion. It is made of 3.5mm stainless steel sheet with a diameter of 455mm and a height of 380mm.

2.2.4 The Hammer

This is designed to act as beaters. They are attached to a central shaft to provide the size reduction effect on the palm fruit. On the other side of it a pulley is fitted to the hammer shaft to provide the drive from the electric motor via the v-belt. The hammers are eight in number. They are made of 37.5×37.5×500 mm angle iron.

2.3 Description of the Machine

The developed palm fruit digester (Figure 3) was designed, fabricated and assembled at the workshop of Agricultural and Bioresources Engineering, University of Nigeria, Nsukka. The machine consists of a hopper, frame, digesting chamber and hammers enclosed in the digesting chamber.

Cooked or uncooked palm fruit is fed through a hopper which is trapezoidal in shape, made of 3.5 stainless steel, welded at an angle of repose of 45^o to an orifice that empties into the digesting chamber. In the digesting chamber are eight sets of hammers attached to a centrally placed vertical shaft. As the hammers rotate, they help in the pulping/digestion of the palm fruits. On the end side of the hammer shaft, a pulley is fitted to the hammer shaft to provide the drive from the electric motor of 3 horse power via the v-belt. The shaft is made up of 24mm gauge stainless steel. The electric motor revolves at 621.4rpm with belt and pulley connections.

2.3 Machine Component Selection and Design Calculations

2.3.1 Determination of Physical and Mechanical Properties of Oil Palm Fruit

For effective design of the machine, it was necessary to determine the physical and mechanical properties of the oil palm fruits relevant to their behaviour during pulping. The physical properties that were considered in this study are size, shape, true density, bulk density and porosity while the mechanical properties are hardness and shear strength. These experiments were carried out in Agricultural and Bioresources Engineering and civil Engineering Laboratories, University of Nigeria Nsukka.

- *Determination of size*

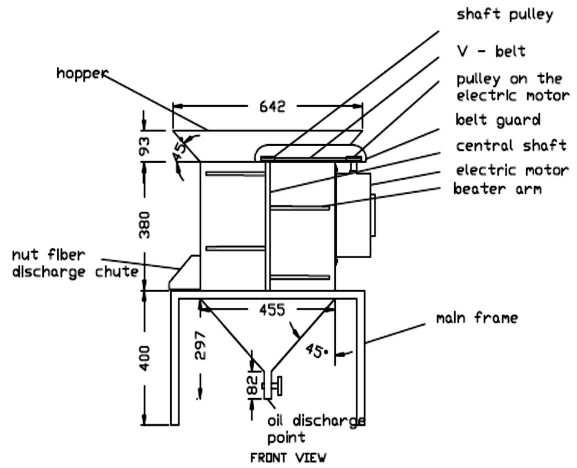
From the samples, 50 fruits were selected at random for determining the physical characteristics. For each fruit, three linear dimensions were measured, that is (a) length, (b) width, and (c) thickness, using a Vernier caliper (Kanon Instrument, Japan) reading to 0.01 mm. Hence measurement of all size indices were replicated three times

- *Determination of shape*

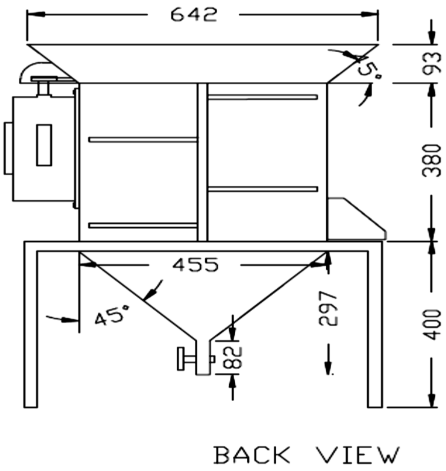
The fruit shape was expressed in terms of its sphericity index and aspect ratio. For the sphericity index (Sc), the dimensions obtained for the 50 palm fruits selected at random in above were used to compute the index based on equation (1) [8].

$$S_c = \frac{(abc)^{\frac{1}{3}}}{a} \times 100 \qquad (1)$$

where a is the major diameter (mm), b is the intermediate diameter (mm), c is the minor diameter (mm) and S_c is the sphericity index.



(a)



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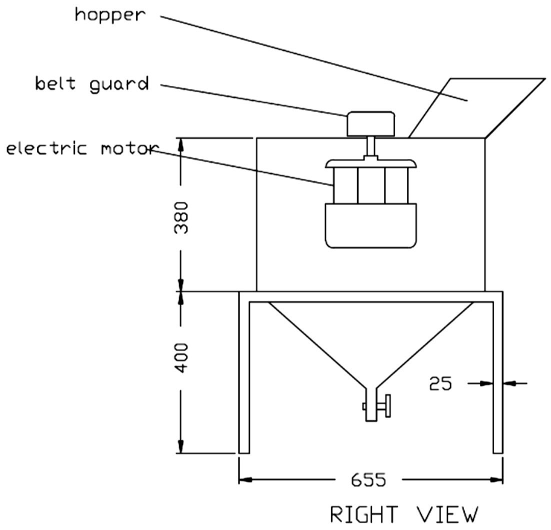
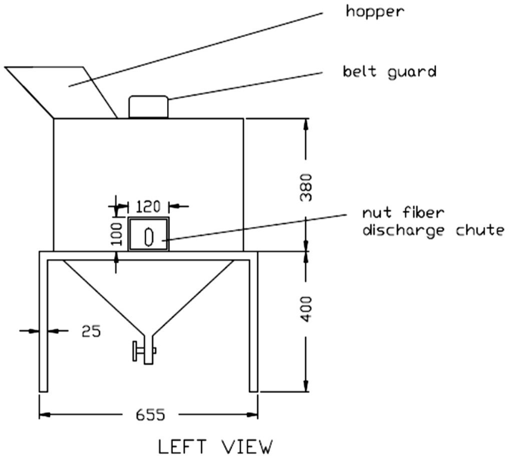


(c)



(d)

Figure 3: Isometric view of the developed oil palm fruit rotary digester

For the aspect ratio, 50 palm fruits were also selected at random for conducting the experiment. Measurements of all size and shape indices are replicated fifty times. The Vernier caliper was also used for the measurements. The aspect ratio (Ra) was calculated as recommended by [9]. This is shown in equation (2):

$$R_a = \frac{b}{a} \times 100 \qquad (2)$$

where a is the major diameter (mm), b is the intermediate diameter (mm) and R_a is the aspect ratio

- *Determination of fruit mass*

The mass of individual fruits were determined by using a Mettler Toledo PB 153 electronic balance (Mettler Toledo GmbH, Greifensee, Switzerland) to an accuracy of 0.001 g. Each measurement was replicated 50 times.

- *Determination of true and bulk density*

The true density of the palm fruit was determined by the water displacement technique [10]. Ten randomly selected palm fruits were weighed and lowered into a graduated measuring cylinder containing 30 ml of water. It was ensured that the fruit was submerged in water. The net volumetric water displacement by each fruit was recorded. The true density ℓ_t was then calculated using equation (3) below:

$$\ell_t = \frac{m}{v} \qquad (3)$$

Where m is the mass of fruit (kg), and v is the volume of fruit (m^3).

For bulk density measurement, an empty cylindrical container of 444.50 cm^3 volume was filled with palm fruits and the bulk weight recorded. This was done in 10 replications.

Using equation above, the bulk density ℓ_b was then calculated for each of the replications.

- *Determination of density ratio and porosity*

The density ratio, Dr is the ratio of true density to bulk density expressed in percentage as shown in equation (4):

$$D_r = \frac{\ell_t}{\ell_b} \times 100 \qquad (4)$$

Porosity (P) was computed as shown in equation (5) [11]

$$P = \frac{\ell_t - \ell_b}{\ell_t} \times 100 \qquad (5)$$

Where ℓ_t is the true density (kg/m^3), ℓ_b is the bulk density (kg/m^3), D_r is density ratio and P is the porosity

- *Hardness and Shear Strength*

In determination of the fruit mesocarp hardness/ shear strength and endocarp hardnes/ shear strength, the sterile test specimens were insert into a tensometer. A uniform shear force was continuously applied until the test specimen start initial fracturing. The shear strength of the mesocarp of the fruit mesocarp and that of the endocarp was deduced using the formular in equation (6):

$$\text{Shear strength} = \frac{\text{Applied shear force}}{\text{Fruit area}} \qquad (6)$$

And hardness of the mesocarp was calculated using ILO [12] formula as stated in equation (7)

$$HBN = \frac{P}{\frac{\pi D}{2}\left[D - (D_2 - d_2)^{\frac{1}{2}}\right]} \qquad (7)$$

Where HBN is the hardness number, P is constant force (= 34.65N), D is the Brinnel bulb diameter (= 2.00mm), d is the depth of indentation (mm)

The data gotten from the above is relevant in maintaining a suitable centrifugal force (Fc) at the course of the design that can completely digest the fruit mesocarp without breaking the palm kernel shell (endocarp).

In view of the experiment carried out, Table 2 shows the comprehensive summary/results of the preliminary experiment. From the table, the mean bulk densities of the three species of palm fruit were used in determining the capacity of the machine (kg). That of the dura species, because of its availability was used as reference in the evaluation of the power requirement of the hammer or beater.

2.3.2 Design Calculations

The major designs were on the power requirement, speed of hammer or beater and proper shaft selection.

1. Speed of the Hammer or Beater

Using the theory that the product of the diameter and speed of one pulley is equal to that of the other [13]. The hammer speed was calculated by using equation (8):

$$D_1N_1 = D_2N_2 \qquad (8)$$

where D_1 is the diameter of the pulley on electric motor (m), D_2 is the diameter of pulley attached to the hammer shaft (m), N_1 is the speed of electric motor (r.p.m), N_2 is the speed of the hammer shaft (r.p.m):

$$N_2 = \frac{D_1N_1}{D_2} \qquad (9)$$

2. Centrifugal Force Developed in the System

Centrifugal force (Fc) developed in the barrel was deduced as follows [14]:

$$Fc = M\omega^2 r_1 \qquad (10)$$

where M is the inertia mass of the hammer before attaching to the shaft (kg), ω is the angular velocity of the hammer shaft (rad/sec) and r_1 is the radius of the hammer shaft (m)

$$\text{But } \omega = \frac{2\pi N_2}{60} \qquad (11)$$

Therefore, equations (10) and (11) becomes:

$$F_c = M\left[\frac{2\pi N_2}{60}\right]^2 r_1 \qquad (12)$$

Centrifugal force developed in the beater was then obtained from (12) as 122N.

3. Torque Developed

The torque in the design is considered here so that the idea of the capacity or power of the electric motor to be used can be determined. Using the expression by Kurmi and Gupta [15] that torque (T) is equal to the product of force and radius, the value of the torque developed on the pulley of the hammer shaft can be calculated using:

$$T = F_c r_2 \qquad (13)$$

Where F_c id the centrifugal force developed in the barrel, r_2 is the radius of pulley on the hammer shaft. So the torque developed in the system will be 8.57Nm.

2.3.3. Power Requirement, Tension in the Belt and Shaft Selection

The power requirement of the machine was determined with the expression by Kurmi and Gupta [15] which states that power is the product of torque (T) and angular velocity (ω) as:

$$P = T\omega \qquad (14)$$

But $\omega = \frac{2\pi N_2}{60}$, therefore (14) becomes:

$$P = \frac{2\pi N_2 T}{60} \qquad (15)$$

where P is the Power (Watt) , N is the speed of shaft (r.p.m) and T is the torque required to turn the shaft (Nm). Therefore 2hp was selected to give the required torque in the system.

1. Tension in the V-belt

Tension in the v-belt was deduced by applying Kurmi and Gupta [15] formula shown in equation (15)

$$\frac{T_1}{T_2} = \ell^{\theta\mu} \qquad (16)$$

where T_1 is the tension on the tight side of the belt, T_2 is the tension on the slack side of the belt, μ is the coefficient of friction and θ is the angle of wrap in radians.

But for v-belts

$$\frac{T_1}{T_2} = 3 \qquad (17)$$

Where the factor 3 is a constant for v-belts

Therefore, $T_1 = 3T_2$ (18)

Since $T_1 = F_c$ (19)

Therefore,

$$T_2 = \frac{F_c}{3} \qquad (20)$$

Effective tension on the belt then becomes 81.3N.

2. Shaft Selection

The machine shaft was selected using the code of America Society of Mechanical Engineers (ASME) equation for solid shaft having little or no axial loading shown in (21).

Where,

$$d^3 = \frac{16}{\pi S_s}\left[(K_b M_b)^2 + (K_t M_t)^2\right]^{1/2} \qquad (21)$$

where d is the diameter of shaft (m), S_s is the ultimate stress of mild steel without key way (= *55 N/m²*), K_b is the combined shock and fatigue factor applied to bending, moment is 1.5, M_b is the maximum bending moment (Nm), K_t is the combined shock and fatigue factor applied torsional moment (=1.0) and M_t is the maximum torsion moment (Nm)

2.4 Performance Test Procedures.

2.4.1 Sourcing and Preparation of the Test Sample

A bulk sample of matured palm fruit (dura specie) of about 240kg was procured from the main market, Nsukka, Enugu State, Nigeria. The palm fruit was inspected to ascertain its quality. The fruits were cleansed and washed for dirt and other contaminants. Samples were collected to determine the initial moisture content. After the digester has been assembled and installed, two different sets of experiments were carried out using the oil palm fruits. In the first experimental plan, the optimal speed of the digester was determined. Ten different samples of boiled fresh oil palm fruit weighing 5kg each was fed through the hopper for digesting after starting the machine. In each of the ten trails with different operational speed of 581.4, 591.4, 601.4, 611.4, 621.4, 631.4, 641.4, 651.4, 661.4 and 671.4rpm, a stop watch was used to monitor the time taken for the digestion

In the second experiment, the performance of the digester was evaluated by determining the rate of digestion, D_C (Kg/hr) and efficiency, η (%).

$$D_c = \frac{W}{T_a} \times 60 \qquad (22)$$

where, D_C is the rate of digestion (kg/hr) and T_a is the average digestion time (mins).

$$\eta = \frac{W_d}{W} \times 100 \qquad (23)$$

Where, η is the efficiency(%), W_d is the weight of the digested fruit collected at the outlet of the digester (kg) and W is the initial weight of the palm fruit fed into the digester(kg). Twenty different samples of fresh palm fruit of weight 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100 and 105kg were fed through the hopper of the digester at an optimal operational speed of 621.4rpm. A stop watch was used to record the digestion time taken for each of the twenty trials.

3. Results and Discussion

Data from the first experiment shown in Table 1 showed that the optimal speed of the digester is 621.4rpm. This is because from the speed of 621.4rpm upwards, the digestion time is almost the same. Table 1 also showed that as the speed increases, the digestion time decreases.

The digester performance result presented in Table 2 shows that the digesting capacity, D_c and efficiency, η are 117.93kg/hr and 64.88% respectively. Expectedly, increase in mass of the palm fruit increases the digestion time and the digesting capacity of the digester. In some cases, the efficiency of the palm fruit digester, increases with increase in the mass of the palm fruit, while in most cases there is a significant increase in the efficiency of the oil palm fruit rotary digester. This agrees with an earlier design Ugoamadi [16] for cassava pelleting machine

The developed oil palm fruit digester was found to perform satisfactorily with all the mass of the fresh palm fruit poured into it at constant operational speed of 621.4rpm when tested. The highest digesting efficiency of 71.73% with a digesting capacity of 143.31kg/hr was obtained when an initial palm fruit mass of 75kg was digested. The amount of digested and undigested fruit produced from this are 53.8kg and 21.2kg respectively. The digester capacity could be increased for large scale digestion of palm fruits.

Table 1: Determination of optimal speed of oil palm fruit digester for a fruit weighing 5grams.

S/n	Speed (rpm)	Time of digestion mins)
1	581.4	8.50
2	591.4	7.60
3	601.4	6.70
4	611.4	5.8
5	621.4	4.98
6	631.4	4.98
7	641.4	4.98
8	651.4	4.97
9	661.4	4.97
10	671.4	4.96

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Table 2: Determination of digesting capacity and efficiency of the developed rotary oil palm fruit digester.

Test	Initial weight of palm fruit, W(kg)	Weight of digested fruit, W_d(kg)	Weight of undigested fruit, W_u(kg)	Average digestion time, T_a(min)	Average digestion time, T_a(hrs)	Digesting capacity, D_c(kg/h)	Efficiency, η (%)
1	10.00	5.20	4.80	6.80	0.11	88.24	52.00
2	15.00	8.80	6.20	10.80	0.18	83.33	58.67
3	20.00	10.20	8.80	12.30	0.21	97.56	53.68
4	25.00	12.90	12.10	14.30	0.24	104.90	51.60
5	30.00	16.90	13.10	14.80	0.25	121.62	56.33
6	35.00	21.50	13.50	16.90	0.28	124.26	61.43
7	40.00	26.00	14.00	20.10	0.34	119.40	65.00
8	45.00	30.30	14.70	21.90	0.37	123.29	67.33
9	50.00	33.70	16.30	24.20	0.40	123.97	67.40
10	55.00	38.10	16.90	23.10	0.39	142.86	69.27
11	60.00	43.00	17.00	25.90	0.43	139.00	71.67
12	65.00	47.00	18.00	29.20	0.49	133.56	72.31
13	70.00	50.10	19.90	30.20	0.50	139.07	71.57
14	75.00	53.80	21.20	31.40	0.52	143.31	71.73
15	80.00	57.00	23.00	38.90	0.65	123.39	71.25
16	85.00	59.20	25.80	40.20	0.67	126.87	69.65
17	90.00	60.50	29.50	44.30	0.74	121.90	67.22
18	95.00	63.20	31.80	50.60	0.84	112.65	66.53
19	100.00	66.20	33.80	60.10	1.00	99.83	66.20
20	105.00	70.10	34.90	70.30	1.17	89.62	66.76

4. Conclusion and Recommendation

4.1 Conclusion

The palm fruit digester so far developed is easy to operate. Testing and performance evaluation of the system showed that the system can be recommended for use by farm cooperatives in rural communities. Therefore manufacturers should take up this innovation of the motorized oil palm fruit rotary digester and implement it in the mass processing of red oil palm fruit for export, domestic and industrial uses

4.2 Recommendation

In a bid to achieve the millennium development goals (MDGs) and vision 20:20:20 of the current federal government in the area of agriculture and industrial raw material development as well as food security and employment, government should take advantage of this innovation. Short and medium term loans should immediately be granted to farmers to enable them adopt this important innovation for mass production of red oil palm in other to meet the growing demand of the nations industry, local consumption and for export. Oil palm fruit farmers and local oil palm fruit processing industries are encouraged to patronize this innovation and to increase their profit. The use of this innovation other than the commonly used manual type will attract youths and more investors in this sector as drudgery and tedium has been removed. Optimization of the oil palm digester to determine its optimum performance parameters is recommended because many operational parameters of this affect its performance differently at the same level.

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