

# Design and Fabrication of Melon Shelling and Separating Machine

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**Abstract**— Although there are several designs on melon shelling machines, it is observed that these available designs in the market are relatively more sophisticated and expensive hence they are not affordable to majority of local farmers. The aim of this work is to design and fabricate cheap and affordable melon shelling and separating machine which can effectively shell all the species of melon through electric powered operation, with little or no technical skill required for its operation and at a cheap affordable price using local available materials. The machine was evaluated to determine the percentage number of shelled and unshelled melon seeds, shelled but broken seeds and the partially shelled melon seeds at 7% and 10% wb and concave speeds of 750, 950 and 1200 rpm. At concave speeds of 750, 950 and 1200 rpm, and moisture content (MC) of 7% wb, the calculated shelling capacity of the Sheller were 65, 128 and 148kg/h respectively. The cleaning capacity was 52kg/h, 85kg/h and 85kg/h respectively. When the MC of the melon seeds was increased to 10% wb by sprinkling the seeds with water and allowing it to dry by natural air, the shelling capacity became 53kg/h, 88kg/h and 145kg/h for the concave speeds of 750, 950 and 1200 rpm respectively. At 10% MC the cleaning capacity reduced from 53kg/h to 39kg/h at the speed of 750rpm and from 85kg/h to 66kg/h at the speed of 950rpm. However, at 1200rpm the cleaning capacity increased from 85kg/h to 109kg/h. The fraction of fully shelled melon seeds at mc of 7% wb using the concave speeds of 750, 950 and 1200rpm were 54%, 45% and 45%, while percentage of broken seeds were 85, 95 and 97%, and the number of partially shelled seeds were 42%, 54% and 54%; the percentage number of unshelled seeds were 3.9%, 1% and 0.3%. Moreover, , at the MC 10% wb using the same concave speeds of 750, 950 and 1200rpm the percentage number of broken seeds reduced to 0.8%, 2.3% and 8.9%. Based on this result, the machine is found to be very effective in peeling melon seeds at 10% M.C and at a concave speed of 1200rpm since the ratio of the number of unshelled melon seeds to the quantity in each sample is very negligible.

**Keywords**— shelling and separating machine, fully shelled seeds, shelled broken seeds, partially shelled seeds, moisture content, cleaning capacity.

## I. INTRODUCTION

### 1.1 Melon cultivation:

Melon (*Citrullus Vulgans*), is a common vegetable crop which is widely cultivated in Nigeria (Fadamoro, 1999; Oluwale and Adedeji, 2012). Oni, (2005) classified melon as a legume crop because it has the capacity of preventing or controlling the growth of weeds on the farm and can add Nitrogen to the soil through the process of Nitrogen fixation. Melon can normally be planted twice in a year - during the rainy season and during the dry season and that it is most common in Northern parts of Nigeria particularly Kano, Kaduna and Jos. After harvesting melon, the seeds are carefully removed from the pod and washed very well with water. Solar energy is then used in the conventional way to dry them (Carter, 2002, Ogwo and Oranu, 2006).

The processing of melon is imperative to further diversify its use. This includes shelling, washing, coring, drying, fermenting, drying and extracting of oil. Shelling involves removing the outermost part (husk) from the melon kernel. Here, the seed is separated from the spiny husk. This operation can be carried out in the field or at the storage environment (Nwakire *et al.* 2011). This research therefore seeks to offer assistance to the teaming population of local melon farmers or traders and medium scale industries involved in the melon business in their quest for a convenient, available and easy method of shelling their melon which in most cases is still being done manually due to either very high cost or unavailability of shelling machines

## 1.2 Uses of Melon:

Melon (*Colocynthiscitrullus L.*) is an extensively cultivated and consumed oil seed crop in Nigeria and West Africa (Bankole *et al.* (2005). Okokon *et al.* (2010), reported that melon is the fourth most important crop in the world in terms of production after orange, banana and grapes. These seeds are vastly nutritious, furnishing the human diet with good quality proteins (Ogbonna and Obi, 2007). It contains about 41.51% essential amino acids (Sabo *et al.* 2015) and other essential nutrients (Nwakire *et al.* 2011; Shittu *et al.* 2002). Melon seeds are of great economic importance in Nigeria. They are used for soup preparation (Oke, 1996; Obienwe, 2002). Thus, melon seeds are the major condiments in the popular “*egusi*” soup in every part of Southern Nigeria. In other words, Melon seeds can be used for the following purposes: soup thickeners, for preparation of vegetable oil, livestock feed, preparation of melon cake and food for man (Amudu, 1981; Babale, 1988; Oni, 2005).

Melon seed is also a good source of minerals, vitamins, oil and energy in the form of carbohydrates (Olaniyi, 2008). The seed contains 0.6 g proteins, 4.6 g carbohydrates, 33 mg vitamin C, 0.6 g crude fiber, 230 mg K, 16 mg P, 17 g Ca per 100 g edible seeds and unsaturated fatty acids (Mohammed, 1989).

According to Bankole *et al.* (2005), it is grown mainly for the use of its shelled kernel. This can be sprinkle into a soup or stew and can also be ground into a thick paste. It can also be transformed into products such as “ogiri,” baby “robo cake” and livestock feed, whereas its oil is used in the production of soap and local pomade (Oyawole and Adeniyi, 2009; Shittu and Ndrika 2012).

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## 1.3 Shelling of melon seeds:

One of the greatest problems affecting technology development and indeed agricultural development in Nigeria is the absence of cheap processing equipment (Shittu and Ndrika, 2012). The available agricultural processing machines and equipment in the market are very expensive and cannot be conveniently afforded by many local farmers in the country. Secondly, the designs of the available ones are sophisticated and cannot easily be operated by the local farmers. Also, lacks of their spare parts render them un-sustainable. All these add to make melon cultivation and processing difficult and thus, limit its massive production and therefore scarce in the market..

Although there are several designs on melon shelling machines, it is observed that these available designs in the market are relatively more sophisticated and expensive hence they are not affordable to majority of local farmers. The old traditional methods of shelling melon are still in use in rural areas which involve hurling the melon shell with bare hands. This method is too slow, time consuming, drudgery, and in-efficient.

Shelling of melon as a unit operation is an important step towards the processing of melon to its finished products. Most farmers, who cultivate this crop in Nigeria and West Africa, encounter several processing challenges of its shelling as it requires relatively high expenditure of human energy that is a major concern (Odigboh, 1979; Kafi, 1980; Shittu and Ndrika, 2012). The inability to effectively shell melon in order to meet the requisite quantity necessary for industrial utilization has been a hindrance to its use for large-scale production of various commodities (Nwachukwu, 2001; Adekunle *et al.* 2009). Melon is conventional method of shelling melon is manual which is inefficient, tedious and time consuming, thus limiting the availability of the product in the market (Pradhan *et al.* 2010; James *et al.* 2011). Furthermore, this obsolete method results in bruising and injury to the human fingers, coupled with low output rates (Nkakini *et al.* 2007). Thus, the quest for a satisfactory, cheap and effective means such as mechanized shelling technique is of importance, for small- and medium-scale farmers in Nigeria. Different forms and types of melon sheller exist, according to their source of power, and can thus be classified as electrically powered or fuel-driven melon sheller (Adekunle *et al.* 2009; James *et al.* 2011).

## 1.4 Material Separation

According to Oja (1991), a mixture is a substance which contains two or more substances physically combined together. Mixtures of substances can be separated by physical means. There are varieties of physical methods used to separate variety of mixtures. The particular method employed for any given mixture depends upon the nature of the constituents such as: the relative sizes and shape of the constituents, the weight, boiling point, melting point and density of the constituents..

Henderson and Perry (1981) identified four common methods used for separating a mixture of grain seeds from their shells or husks. These are: handpicking, sieving, inclined surface and blowing. By the hand picking method, the components that are bigger in size are first handpicked leaving the ones that are smaller in size. For example, a mixture of maize and sand, rice and beans, palm kernels and its shells, beans and its shells, etc. This method can also be used for separating melon seeds from its shells after peeling. This sieving method involve pouring the mixture on a sieve and shaking it so that the constituent that is smaller in size will pass through the sieve leaving the other constituent on top of the sieve. Sieving can be used to separate a mixture of rice and sand, beans and rice, oil palm fruit and its husks, etc.

The inclined table method, according to Henderson and Perry (1981), involves the pouring of the mixture on an inclined surface so that the seeds will roll down leaving the husks, shells or debris on the upper part of the inclined surface. This method is mostly used for separating seeds that are round or oval in shape from their shells. For example, it is widely used for separating palm kernels seeds from its shells and oil palm fruits from its husks or debris. The last method, blowing involves blowing the mixture either by mouth or through a mechanical or electrical method so that the lighter constituent in the mixture will be blown off leaving the other constituent behind. This method is very good in separating melon seeds from its shells as well as for separating rice from its husks.

## II. MATERIALS AND METHODS

### 2.1 Materials:

The materials required for the project include: mild steel sheets, 1 inch angled iron bars, 2 inches pipes, welding electrodes, soft solders, soldering flux, emery cloth, assorted bolts, nuts and screws, varnish, paint, 1.5 gauge coil wire, belts and flexible wires and electric motor.

### 2.2 Tools:

The following hand tools were used in the design and construction of the melon peeling and separating machine: steel rule, measuring tape, scribe, center punch, hacksaw, bench shears, cold chisels, assorted files, taps and dies, a pair of pliers, screw drivers, bench vice, hammer and spanners. The machine tools used included welding machine and their accessories, drilling machine and spraying machine.

### 2.3 Methods:

Some physical, mechanical and gravimetric properties of melon seeds were studied and employed in the design and fabrication of the machine. Some physical and gravimetric properties of melon seeds at 6.25% (d.b) such as the mean values of angle of repose, bulk density, porosity and seed dimension of melon seeds influenced the design configuration of the hopper, shelling mechanism and the delivery chute. The mass, true and bulk densities of the seeds were employed in the shaft design and power requirement determination. The moisture content of melon seed samples were determined by the oven drying method.

### 2.4 Physical, Gravimetric and Frictional Properties of Melon Seeds:

Some physical, gravimetric and frictional properties of melon seeds that are pertinent to the mechanical processing determined by Davies (2010) are considered by the design and the development of the machine. The properties of the melon variety *Citrullusedulis* that was used are presented in Tables 1 and 2.

**TABLE 1**  
**SOME PHYSICAL PROPERTIES OF MELON (*CITRULLUSEDULIS*) SEEDS AT 6.25% (D.B.)**

S/N	Properties	No of samples	Mean Values
1.	Length (mm)	100	12.81
2.	Width (mm)	100	7.02
3.	Thickness (mm)	100	2.22
4.	One thousand unit mass (g)	50	94.0
5.	Arithmetic mean diameter (mm)	100	7.36
6.	Geometric mean diameter	100	134.64
7.	Sphericity	100	0.47
8.	Surface area (mm)	50	134.64
9.	Volume (mm <sup>3</sup> )	100	154.83

**TABLE 2**  
**SOME GRAVIMETRIC AND FRICTIONAL PROPERTIES OF MELON SEEDS (*CITRULLUSEDULIS*) AT 6.25% (D.B.)**

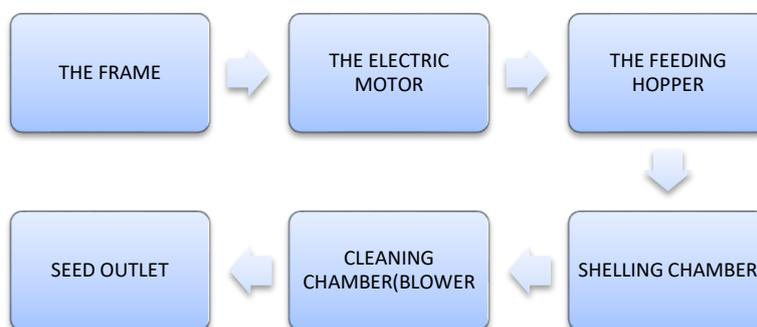
S/N	Properties	Mean Value
1.	Bulk density (kg/m <sup>3</sup> )	405
2.	True density (kg/m <sup>3</sup> )	816.83
3.	Porosity %	53.7
4.	Angle of repose (degree)	36
5.	Coefficient of static friction on Glass	0.35
6.	Plywood	0.51
7.	Galvanized metal	0.43
8.	Concrete	0.56

*Source: Davies (2010).*

Parameters such as, angle of repose, bulk density, porosity, seed dimensions and seed shape influence the sizing and the shape of feed hopper, rotor and delivery chute. Seed mass, true and bulk densities are parameters that dictate the speed of prime mover that provides adequate seed momentum in the shelling unit.

## 2.5 Design Procedure:

The sequential procedure for construction design and construction of the Mellon Sheller is presented in the block diagram as shown in Fig. 1 below.



**FIGURE 1: Sequential constructional procedure of the Melon Sheller.**

## 2.6 The components of the Melon Sheller:

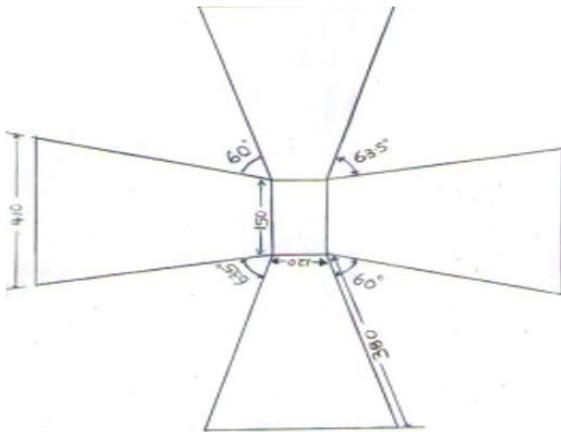
The major components of the Melon Sheller are: the frame, hopper, shelling and the cleaning chamber.

### 2.6.1 The frame:

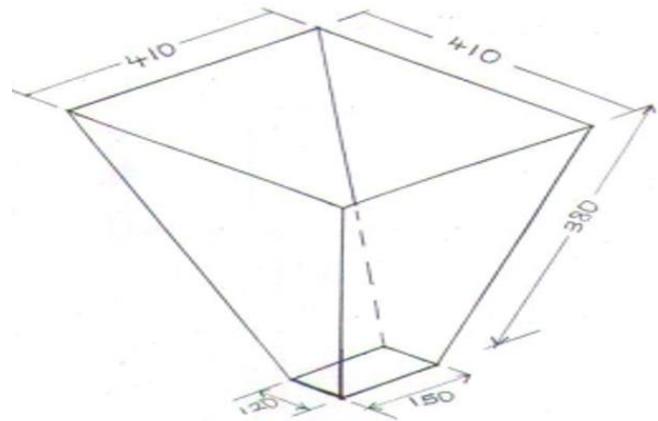
The frame is the support on which the whole unit rest. It bears the load and vibration of the machine. It is a rectangular block that is made of mild steel. The various pieces are joined together by welding to ensure that it is strong, studded and does not shake nor wobble. Four holes are drilled on the mild steel plate for bolts which holds the electric motor firmly in position.

### 2.6.2 The hopper:

The hopper is made up of four welded metal sheets slanting towards an opening to form a trapezium with two openings. The larger upper opening is for introducing the melon seeds into the sheller while the smaller lower opening connects and opens directly into the shelling unit through a centralized hole. It is meant to receive the melon seeds before they are eventually moved into the shelling chamber. The hopper is made up of four welded mild steel metal sheet of thickness 2mm slanting towards the sheller. The mild steel metal sheet was marked out with the aid of set square, steel rule and scribe. An allowance of 10mm was given on all edges of the sheet to cater for hemming. Cutting was done with a shearing machine, chisel and hammer. The cut out sheet was later folded and thereafter welded using manual arc welding machine.



**FIGURE 2: Development of the Hopper**



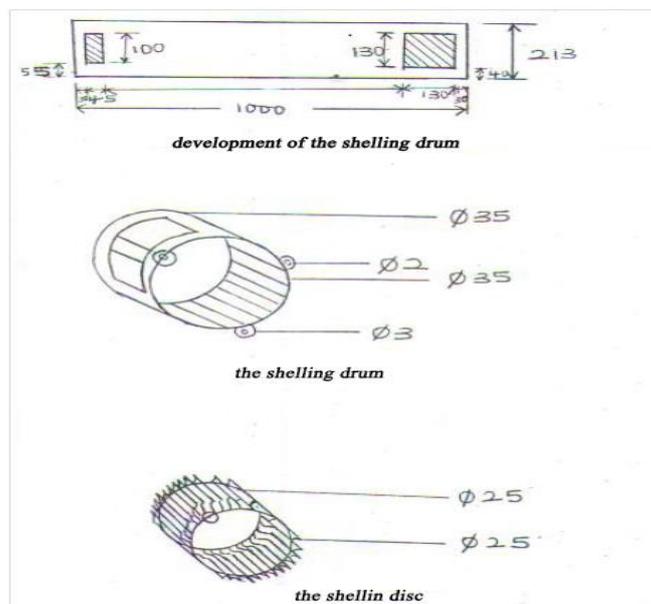
**FIGURE 3: The Hopper**

**2.6.3 The Shelling Chamber:**

The shelling chamber consists of concave and cylinder (convex), shelling drum powered by an electric motor. The concave is made from mild steel and the inner part of the drum is lined with tinny metal rods, while the cylinder is lined with flat metal blades. The cleaning chamber is made of galvanized mild steel plate folded to form a pipe. A regulated fan is installed at one end of the pipe to supply air that will separate the chaff from the cotyledon after shelling. The sheller employs the principle of energy absorption by the melon seeds, as a result of collision between the seeds and the stationary wall of the drum and this causes the cracking and removal of the husk from the seed.

Unshelled melon seeds are fed into the hopper of the sheller when the sheller attains a speed of about 950rpm after which the seed control device is opened to allow the seeds to fall directly into the shelling chamber. The melon seeds that dropped into the shelling chamber from the hopper move anticlockwise in the space between the vanned rotating disc and the rough stationary drum. Since the average thickness of melon seed is 2.5mm, the seed will tend to move in a single row. The rotation of the impeller causes the removal of the coat from the cotyledon of the seeds as they rub against the rough surface of the fixed wall of the drum.

The chaff and the cotyledon will fall by gravity into the cleaning chamber of the sheller. A regulated fan installed in the chamber blows off the chaff and the cotyledons will fall by gravity and are collected at the seed discharge unit of the sheller. The air velocity in the cleaning chamber must be less than the terminal velocity of the melon seed.



### 2.6.4 Cleaning chamber:

The cleaning unit is meant to facilitate the separation of the shelled melon seeds from the chaff. The cleaning unit consists of mild steel folded and welded to form a hollow cylinder that lye horizontally. A regulated fan (relative to the speed of the shelling unit) is installed at one end of the cylinder to supply air for separation of the chaff from the cotyledon after shelling. An outlet chute is created at the base of the cylinder which serves as the outlet for collection of the cleaned melon seeds.

### 2.6.5 Electric Motor:

The electric motor is meant to transmit power or rotational motion to the shelling disc through its protruding shaft with the aid of a key that fastened them together. The power rating of the electric motor is 2hp.

### 2.6.6 Power Requirement:

The total power required is calculated using the equation as specified by Odigbo, (1979) and as cited by Oluwole and Adedeji, (2012).

$$PT = P_{\text{inner drum}} + P_{\text{shaft}} + P_{\text{shelling}} \quad (1)$$

Where:

PT = total power required.

$P_{\text{shelling}}$  is negligible since seeds are not resident in sheller but flow through in pieces.

$$\text{Therefore, } PT = P_{\text{inner drum}} + P_{\text{shaft}} \quad (2)$$

But the shaft and inner drum were welded together, so that

$$PT = P_{\text{inner drum with shaft}}$$

$$P_{\text{inner drum with shaft}} = T_{\text{inner drum with shaft}} \times V_{\text{inner drum with shaft}}$$

$$V_{\text{inner drum with shaft}} = \frac{2\pi N}{60} \text{ m/s}$$

$T_{\text{inner drum with shaft}}$  is the torque (Nm)

$N$  = is the number of revolution per minute of the inner drum with shaft = 350 rpm  $T_{\text{inner drum with shaft}} = \text{mass} \times \text{acceleration due to gravity} \times \text{radial distance}$

But the Mass of the inner drum with shaft = 5.6kg,

Acceleration due to gravity = 10 m/s<sup>2</sup>

Radial distance = 0.127m

$$T_{\text{inner drum with shaft}} = 5.6 \times 10 \times 0.127 = 7.112 \text{ Nm}$$

$$P_{\text{inner drum with shaft}} = 7.112 \times \frac{2 \times 3.14 \times 350}{60 \times 1000} = 0.2607 \text{ KW} = 0.349 \text{ Hp}$$

Using the factor of safety of 2, power required is 0.70Hp; therefore a motor of 1Hp is chosen to power the inner drum, shaft for shelling the seeds. However, in practice 2Hp was used instead.

### 2.6.7 Terminal velocity:

Pneumatic separation of grains involves the separation of foreign materials from the grain with the aid of air stream. The air is made to pass through the disposed material to affect their separation. The design of fan for effective grain cleaning takes advantage of the variation in the aerodynamic properties of the grain (Ogunlowo and Ademosun, 1990). The terminal velocity of the shelled seeds and chaff will be determined as follows:

$$Mg = \frac{1}{2} \rho V_t^2 C_d A \quad (3)$$

Where:

$M$  = mass of the object (kg);  $g$  = gravitational acceleration (m/s<sup>2</sup>);  $C_d$  = drag coefficient;  $\rho$  = air density (kg/m<sup>3</sup>);  $A$  = projected area (m<sup>2</sup>);  $V_t$  = terminal velocity (m/s).

### III. RESULTS AND DISCUSSIONS

#### 3.1 Assembling of the Final Product:

Assembling of the final product was done after the different component parts of the melon shelling and separating machine was constructed using the sequential constructional procedure. Two types of joints were used during the process. These were permanent joints and temporary joints. Permanent joints were used in joining the feeding hopper to the top of the peeling chamber through the process of welding. The separating port was also welded to the main frame. Bolts and nuts were used to fasten the three main components of the machine namely the electric motor, peeling chamber and blower unit to the main frame.

The need to use bolts and nuts for these components was to produce temporary joints which could facilitate easy detachment of any of these component parts during maintenance operations. Lastly, the power cord was connected to the electric motor and its free end was fitted with a three-prong plug. After the assembling, the machine was cleaned with emery cloth and wire brush to remove dirt and dust. Thereafter, paint was applied to it to give it a smooth finish and a beautiful appearance. The completed product is as shown below in Fig. 4.

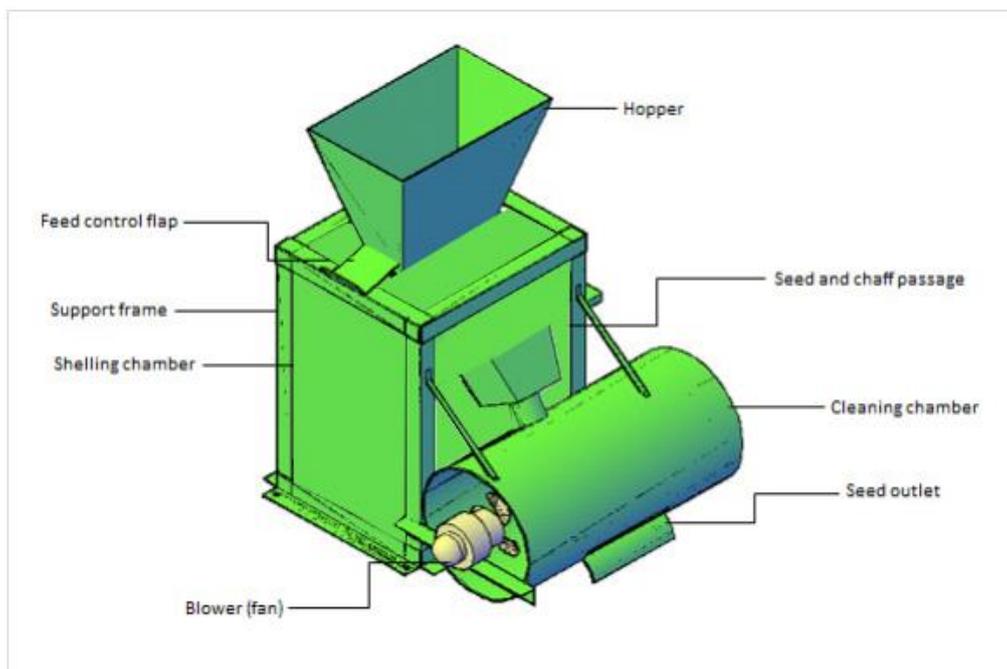


FIGURE 4: Orthographic view of the machine

#### 3.2 Operation of the Melon Shelling and Separating Machine:

The power cord of the machine should first be plugged into the electric mains after which the machine is switched on and left to operate for few minutes to enable it attain its operational speed. The melon seed to be peeled should first be sprinkled with water and allowed for some time to dry up so as to make the seed coat softer which facilitates easy peeling. About 5 kg of melon seeds were fed into the shelling unit through the hopper continuously but gradually. The seeds passed through the lower opening of the hopper onto the vanes into the shelling unit.

In the shelling unit, the melon seeds were thrown against the wall of the shelling drum and the rotating vanes. Through impact of the shelling vanes, walls of the shelling drum, and collision of the seeds with each other, the shells were weakened and subsequently broken. After the shelling process, both mixture of the seeds and chaff fell through a chute, leading to the cleaning unit. In the cleaning unit, a fixed regulated fan separates the shelled seeds from the chaff by air current. The denser shelled seeds fell through the discharge outlet, while the chaff is blown out through a chute opposite the fan.

#### 3.3 Performance Evaluation of the Sheller:

The performance evaluation of the melon sheller was carried out with a 2-horsepower electric motor, using melon seeds of various quantities. The unshelled melon seeds at moisture content of 7% were first shelled at three different speeds of 750 rpm, 950 rpm and 1200 rpm of the cylinder. The second sample of melon seeds was sprinkled with water and partially dried with

natural air for 10 minutes. This made the skin coat to become slightly softened and the cotyledon was easier to detach from the shell, thus making shelling more efficient (Olusegun *et al.*, 2008). The moisture content of the melon seeds that were sprinkled with water and dried for 10 minutes was found to be 10%. This was used for the second test.

The number of seed shelled and unbroken, shelled but broken, partially shelled and unbroken, partially shelled but broken and the number of seeds unshelled were counted separately after shelling operation. The quantity of chaff blown by the fan was also collected and weighed at the different speeds of 750, 950 and 1200 of the sheller.

The number of seeds in sample is represented as  $N_0$ , number of seeds shelled and unbroken as  $N_1$ , number of seeds shelled but broken as  $N_2$ , number of seeds partially shelled and unbroken as  $N_3$ , number of seeds partially shelled but broken as  $N_4$  and number of seeds unshelled as  $N_5$  (Odigboh, 1978). The shelling capacity of the machine was calculated as the weight of the sample shelled per unit time.

$$\text{Shelling capacity} = W/t_1 \text{ kg/h} \quad (1)$$

The cleaning capacity is the quantity of seeds cleaned

$$\text{Per unit time} = W/t_2 \text{ kg/h} \quad (2)$$

$$\text{Shelling efficiency } E_s (\%) = (100X_a) / (X_a + X_c) \quad (3)$$

Cleaning efficiency

$$E_c(\%) = (100X_d) / (X_d + X_b) \quad (4)$$

Where;

W= weight of the sample shelled

T= time

$X_a$ = weight of seeds received at the seed outlet

$X_b$ = weight of chaff received at the seed outlet

$X_c$ = weight of grain received at chaff outlet

$X_d$ = weight of seeds received at chaff outlet

**Source:** Nigerian Industrial Standard (1997)

$$\text{The fraction of melon seeds completely shelled} = \frac{N_1+N_2}{N_0} \times 100 \quad (5)$$

$$\text{Fraction of seeds partially shelled} = \frac{N_3+N_4}{N_0} \times 100 \quad (6)$$

$$\text{According to (Odigboh, 1978), fraction of seeds unshelled} = \frac{N_5}{N_0} \times 100 \quad (7)$$

### 3.4 Experimental Design and Statistical Analysis:

The experimental design for the statistical analysis (Obi, 1995) follows a 2-treatment effect (moisture content and shaft speed) in a split-plot factorial design with RCBD (Randomized Complete Block Design) involving a 2-way classification. The experimental unit comprises 2 factors (two varieties) in each of the three levels of the shaft speed giving 6- treatment combinations for the three different experiments as follows

- Shaft speed (750 rpm) versus moisture content
- Shaft speed (950 rpm) versus moisture content
- Shaft speed (1200 rpm) versus moisture content

The moisture content has two levels while the shaft speed has three levels. The moisture content separately forms the levels for factor A while the shaft speed in any of the three combinations forms the levels of factor B. On the whole the analysis studied three different operations of shelling capacity, cleaning capacity and percentage of shelling at  $P \leq 0.05$  and  $P \leq 0.01$

#### IV. RESULTS AND DISCUSSIONS

##### 4.1 Results:

Table 3 shows the summary of the measured physical properties of Melon seeds (Bara). The average performance data of the sheller at moisture content of 7% and 10% and cylinder speeds of 750 rpm, 950 rpm and 1200rpm respectively are shown in Table 4, while the performance indices of the sheller are given in Table 5. The calculated power requirement and terminal were 2hp and 6.4m/s respectively

**TABLE 3**  
**SUMMARY OF MEASURED PHYSICAL PROPERTIES OF MELON SEEDS (BARA)**

Parameters	Unshelled Seeds	Shelled +Cotyledon	Shelled Seed	Chaff
7% M.C. Angle of repose ( $\theta$ ) (deg)	35.7	40.5	43.3	-
Coefficient of friction ( $\theta$ ) (deg)	0.72	0.85	0.95	-
10 % M.C. angle of repose ( $\theta$ ) (deg)	36	45.81	44	-
Coefficient of friction ( $\theta$ ) (deg)	0.73	1.03	0.97	-
Weight of one seed (g)	0.124	0.124	0.022	0.0221
Length of seed (mm)	12.4	-	11.0	-
Width of seed (mm)	7.6	-	6.5	-
Thickness of seed (mm)	2.5	-	1.8	-

**TABLE 4**  
**THE AVERAGE PERFORMANCE INDICES OF THE MELON SHELLING MACHINE AT TWO DIFFERENT MOISTURE CONTENTS OF 7% AND 10% AT 3 DIFFERENT SPEEDS OF 750 RPM, 950 RPM AND 1200 RPM.**

Parameters	7%MC			10%MC		
	750	950	1200	750	950	1200
Weight of unshelled seed (g)	7.7	7.1	118.4	11.4	73	120.9
Time to complete shelling $t_1$ (s)	4	2	3	11	3	3
Time to complete shelling $t_2$ (s)	5	3	5	11	4	4
No of seeds in sample ( $N_0$ )	578.5	575	955	955	575	955
No. of seeds shelled and unbroken ( $N_1$ )	36.5	17	18	701	537	836
No of seeds shelled but broken ( $N_2$ )	277	244	228	5	7	58
No of seeds partly shelled and unbroken( $N_3$ )	29	6	2	113	22	26
No of seeds partly shelled but broken ( $N_4$ )	217	305	575	3	7	27
No of seeds unshelled ( $N_5$ )	23	6	3	128	4	8

**TABLE 5**  
**PERFORMANCE INDICES OF THE SHELLING**

Parameters	7%MC			10%MC		
	750	950	1200	750	950	1200
Shelling Capacity (kg/h)	65	128	148	53	88	145
Fully shelled (%)	54	45	45	74	85	93
Partly shelled (%)	42	54	54	12	5	6
Unshelled (%)	4	1	1	13	1	1
Broken (%)	85	95	98	1	2	9
Cleaning Capacity (kg/h)	52	85	85	39	66	109
Efficiency of the Sheller (%)	75	80	82	80	85	90

## 4.2 Discussions:

The parameters studied were the percentage number of shelled and unshelled melon seeds, shelled but broken seeds and the partially shelled melon seeds at 7% and 10% wb respectively; and at the concave speeds of 750 rpm, 950 rpm and 1200 rpm. At concave speeds of 750 rpm, 950 rpm and 1200 rpm respectively at moisture content of 7% wb, the calculated shelling capacity of the sheller were 65kg/h, 128kg/h and 148kg/h respectively. The cleaning capacity was 52kg/h, 85kg/h and 85kg/h respectively. When the moisture content of the melon seeds was increased to 10% wb by sprinkling the seeds with water and allowing it to dry by natural air, the shelling capacity became 53kg/h, 88kg/h and 145kg/h for the concave speeds of 750 rpm, 950 rpm and 1200 rpm respectively as shown in Table 5.

At the moisture content of 10%, the cleaning capacity was seen to have reduced from 53kg/h to 39kg/h at the speed of 750rpm and from 85kg/h to 66 kg/h at the speed of 950 rpm. However, at 1200rpm the cleaning capacity increased from 85kg/h to 109kg/h as showed in Table 5.

The fraction of melon seeds fully shelled by the sheller when the moisture content of the melon seeds remained at 7% wb using the concave speeds of 750 rpm, 950 rpm and 1200rpm respectively were 54%, 45% and 45%. The percentage of seeds broken were 85%, 95% and 97%, the number of partially shelled seeds were 42%, 54% and 54%. The percentage number of melon seeds that were unshelled was 3.9%, 1% and 0.c%. The 97% breakage of the melon seeds was too high for the sheller to operate at those speeds when the melon seeds moisture content was 7% wb. Although all the melon seeds fed into the sheller at the moisture content of 7% were shelled, however, there was high mechanical damage of the seeds which will lead to deterioration of the seeds as was also observed by Shittu *et al.* (2002).

When the moisture content of the melon seeds was raised to 10% wb using the same concave speeds of 750 rpm, 950 rpm and 1200rpm the percentage number of broken seeds reduced to 0.8%, 2.3% and 8.9%.

Based on these results, was concluded that the machine is very effective in peeling melon seeds at 10% M.C and at a concave speed of 1200rpm since the ratio of the number of unpeeled seeds to the quantity in each sample with reduced damage to the seeds very negligible.

**TABLE 6**  
**BILL OF ENGINEERING MEASUREMENT AND EVALUATION**

Items	Quantity	Total (₹)
2 hp Electric motor	1	30,000
Metal sheet	(900mm x 1200mm x 3.5mm)	10,000
Gauge 12 electrode	1 packet	1,500
Body filler	4 liters	4,000
Steel rode Ø30mm	6000m	3,000
Contingency allowance		15,000
<b>Total</b>		<b>63,500</b>

## V. CONCLUSION

### 5.1 Summary of the Method used in the Design and Construction:

The final design of the melon shelling and separating machine was designed and fabricated after careful observation of problems faced by local farmers. A sequential constructional procedure was adopted and the construction of the machine was executed step by step as follows:

1. The main frame was first constructed using angled iron. The various pieces were joined and welded together.
2. The electric motor was attached.
3. The shelling chamber was constructed with mild steel sheets. This was followed by the construction of the shelling rotor which carries the shelling blades.
4. The feeding hopper was made by welding four pieces of mild steel sheets together to form a rectangular-shaped funnel.

5. The blower unit was fabricated by enclosing a small blower in a cylindrically shaped chamber.
6. The separating part was constructed next by welding a piece of mild steel sheet to the main frame at an angle of 45'.
7. The power cord was fixed to three-prong plugs at the end of a cable which was connected to the other end of the terminals of the electric motor.
8. The blower was connected directly to the source

These components were assembled by using bolts and nuts and by welding in some cases. The finished product was cleaned and painted.

## 5.2 Summary of Tests Carried out and Results Obtained:

On completion of the construction, the finished product was tested with various quantities of melon seeds and the peeled melon seeds obtained were closely examined and the number of unpeeled seeds as well as the number of un-separated shells was recorded in each sample.

The result showed that the number of unpeeled melon seeds as well as the number of un-separated shells in each sample was very negligible. Based on this, the melon peeling and separating machine was found to be efficient in peeling and separating melon seeds from the shells.

This study is intended to enhance technological advancement and economic growth by imparting the necessary skills on students of Agricultural Engineering, through design and fabrication of machines that are required in mechanizing some of the operations in agricultural production which would have otherwise been carried out by using humans labour.

In this way, rapid solution to problems is enhanced. It is in this regard that the agricultural processing machines, like the designed and fabricated melon shelling and separating machine becomes inevitable.

## VI. CONCLUSION AND RECOMMENDATION.

A simple melon seed shelling and separating machine has been fabricated, preliminary test were carried out on the melon sheller and separator to ascertain its performance. The cost, safety, maintainability, durability and efficiency were critically taken into consideration during the design. The results of the tests carried out on the machine showed a very remarkable and promising success as far as the functional requirement of the melon sheller is concerned. The machine is sustainable from the fact that the materials used for its fabrication were locally sourced, thus, the spare parts are locally available.

### 6.1 Recommendations

In line with the purpose and result of this study, the following recommendations are made:

1. Attention should be paid to locally design and constructed machine is recommended Nigeria for the fact that it is maintainable and sustainable as the parts for its repair and maintenance can be sourced locally.
2. Government, private entrepreneurs and agricultural research institutes should help in the mass production of this machine.

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