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The Design and Construction of a Melon Shelling Machine using Locally Available Materials

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***Abstract*— Melon shelling in most part of the world is usually done manually by hand, and like all manual operations, it is time consuming and strenuous. The design and construction of motorized melon shelling machine using impact method was done in order to meet the domestic, commercial and industrial demand of melon for food processing and for other industrial uses. The Melon shelling machine is made up of the following main units; hopper, shelling chamber, electric motor and supporting base. The shelling chamber consists of the shelling drum, the shelling vanes and shelling disc. The machine was made from locally sourced materials and it can be used in both urban and rural areas. The average percentage performance of the melon shelling machine was found to be 94.78%.**

Key words: Shelling machine, Hopper, Shelling chamber, Shelling disc, Electric motor, Cracking pot and cotyledon.

I. INTRODUCTION

Melon is widely called 'Egusi' by Yorubas, 'Agusi' by Hausas and 'Ogil' by Igbo people of Nigeria[14]. The main melon species found in Nigeria are Bara, Serewe, Sofin, variety "E" and "N" types [13]. Bara also known as papa has large brown seed with black edges thickened towards the apex, about 16 x 9.5mm and is common in the Northern and Western part of Nigeria. The 100 seed weight is about 14g, while serewe seed are smooth, light brown, with a light whitish edge that is not thickened, about 15 x 9mm in dimension. They are mainly found in the Eastern part of Nigeria. The 100 seed weight is about 12g[4][13]. The variety "E" and "N" types are from Niger and Bendel state respctively. The "E" type has 100-seed weight of 16g and is 16 x 10mm in size. The "N" type is 7 x 4mm in size with a 100-seed weight of 5g[13]. According to [18] the melon seed can be grounded into thick paste for making soup or stew as well as serving as a raw material in the production of margarine, salad, "robo cake" , baby food, livestock feeds, local pomade, soap and its shells can be used as poultry litter.
Despite the large productivity and nutritional potentials of this crop, there has been a hindrance to the use of melon for large scale production of oil and protein sources. This is as a result of inability to shell melon to meet the capacity required for industrial purposes. In order to address the problem associated with melon shelling, several research efforts have been made in designing melon shelling machines. Some of these efforts are reported by [18] as follows;[6] constructed a melon seed shelling machine which works on the principle of bending by feeding seeds through a sets of rollers having ridges on their surfaces, [10] designed an impact egusi shelling machine that works on the principle of impact force from spinning disc, [5] designed and constructed another machine based on principle of friction between a rotating disc and a stationary disc positioned to be parallel to the rotating disc, [9] designed and constructed a melon shelling using the principle of extrusion. Others research works reported by [18] includes those of ; [17], [7], [2], [16], [3], [8], [1]. There was a Federal Government sponsored organization in Kwara State of Nigeria, that is also involved in the design of melon shelling machines, [17]. Some other efforts according to[13] were those of [11] who carried out extensive test on a similar sheller developed along the[10] type, [19] who designed a melon sheller that was based on the principle of frictional force between two plates, one rotary and the other stationary and [20] who constructed and tested the [19] design. However, most of the machines were found to have low efficiencies.
In Nigeria, Farmers and other users of melon perform melon shelling through cumbersome and wasteful manual methods [15]. The traditional method of shelling which is the oldest method of shelling is still in use in the village or rural areas today. Hurling the melon shell is done with bare hands. These methods appear to be too slow, time consuming, tedious, inefficient and involved drudgery, thus limiting the availability of the product in the market. This has given concern to scientist and researchers in the recent past particularly, since women are the major processors of melon especially at shelling stage, [12]. Therefore, taking a careful look at the usefulness of melon, there is a need of efficient means of processing it, so as to increase its productivity, improve the quality of its products and so encourage more farmers to be involved in its growth and production. Processing of melon include fermentation, washing, drying, shelling and oil extraction.
The aim of this work is to design a melon shelling machine which can effectively shell almost all the species of melon found in Nigeria, with little or no technical skill required for its operation and at a cheap affordable price. 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.

II. PRINCIPLE OF OPERATION

The melon shelling machine works on the principle of energy absorbed beyond the elastic limit of the melon seeds as a result of impact force experienced during collision between the seeds and the stationery wall which results in the cracking and removal of the seeds shells. Unshelled melon seeds are fed into the machine through the hopper which opened directly into the shelling unit. The shelling vanes are welded at an angle of 45^0 to the shelling disc in order to increase the speed and rate of collision of the unshelled seeds with the rough body of the shelling unit, thereby leading to the breakage and subsequent removal of the melon shells from the cotyledon. The unshelled seeds and the peeled shells are blown out of the shelling vanes through the conveyor chute under gravity and thus separate the cotyledon from the unshelled seeds and peeled shells. The shelling vanes are welded at an angle of 45^0 to the shelling disc connected to a shaft powered by an electric motor of one horse power (1hp) which rotates at 1400 r.p.m. A ball bearing housing and hanger was designed to stabilize the rotary shaft and reduce vibration, thereby preventing collision of the rotating shelling disc with the stationery wall of the shelling drum and in turn reduce the amount of crushed melon seeds.

III. PRECAUTIONS

For the machine to perform efficiently;

i. Ensure that the machine is operated with the appropriate voltage rating.
ii. The machine should be allowed to run for some seconds before melon seed are fed into the hopper and should be done gradually.
iii. Feeding of the melon into the hopper should be done gradually.
iv. When operating the machine the lever should be properly positioned before feeding the melon into the hopper.
v. After operation, the machine should be properly cleaned.
vi. When not in use, the machine should be switched off.

IV. MATERIAL SELECTION

Material selection was done with due consideration for the following factors; availability, cost, strength and rigidity, resistance to fatigue, resistance to wear and tear and resistance to corrosion

V. METHODOLOGY (FABRICATION PROCEDURE)

The motorized operated melon shelling machine is made up of the following main components.

i. The hopper
ii. The shelling chamber
iii. The electric motor and
iv. The supporting base

A description of various component parts were made with materials used as stated below.

A. *Fabrication Of The Hopper*

The hopper opens directly into the shelling unit through a centralized hole. The hopper 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 slanting toward the smaller opening. The mild steel metal sheet was marked out with the aid of set square, steel rule and scriber. See fig1a. 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. See fig1b.

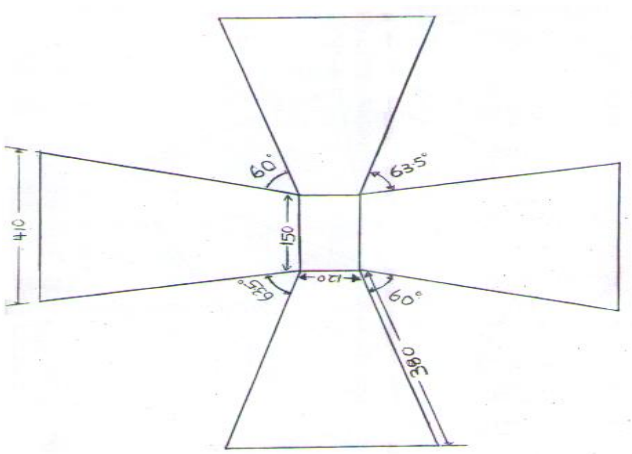

FIG 1a: THE DEVELOPMENT OF THE HOPPER

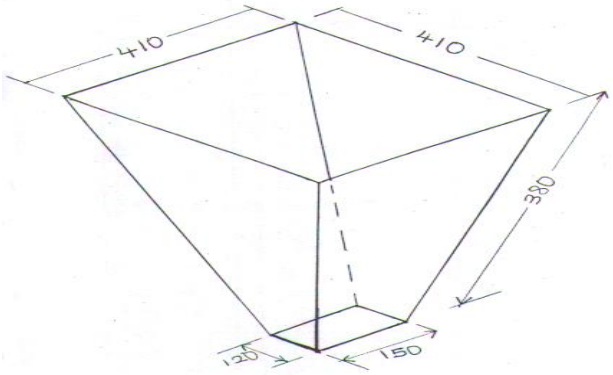

FIG. 1b: THE HOPPER

(All Dimensions Are In mm)

B. *Fabrication Of The Shelling Chamber*

The shelling chamber consists of the shelling drum, the shelling vanes and shelling disc. The shelling drum was made from mild steel and the inner part of the drum is lined with ¼ inch rods. See fig 2a and fig 2b. The shelling disc was made from mild steel and has vanes slots at the edges. The shelling vanes are made from mild steel. They are arranged side by side at an angle of 120^0 to each other and welded to the shelling disc at an angle of 45^0. See fig 2c. The shelling chamber incorporates an opening at the bottom part which serves as an outlet for the shelled melon seeds.

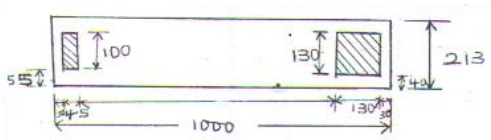

FIG. 2a: THE DEVELOPMENT OF THE SHELLING DRUM

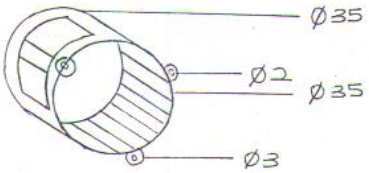

FIG. 2b: SHELLING DRUM

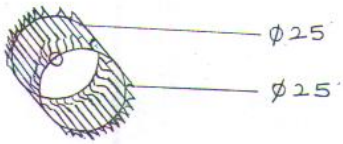

FIG. 2c: THE SHELLING DISC

(All Dimensions Are In mm)

C. *Electric Motor*

The electric motor is used 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 1hp. The electric motor was bought already made from the market.

D. *Fabrication Of The Frame And Supporting Base*

The frame is the structure that holds all the components together. It was constructed with 25mm square hollow pipe with 2mm thickness and metal plate of 450mm by 375mm with 3mm thickness. The metal plate was welded to the frame after measurement and cutting it to size. The base is the structure that supports the electric motor and the shelling chamber to the frame. The base was constructed with flat bars of 35.5mm with 3mm thickness. 12mm rods of different length were used to braze the shelling drum and the electric motor to the frame to reduce vibration and enhance rigidity. See fig 3a. and fig 4

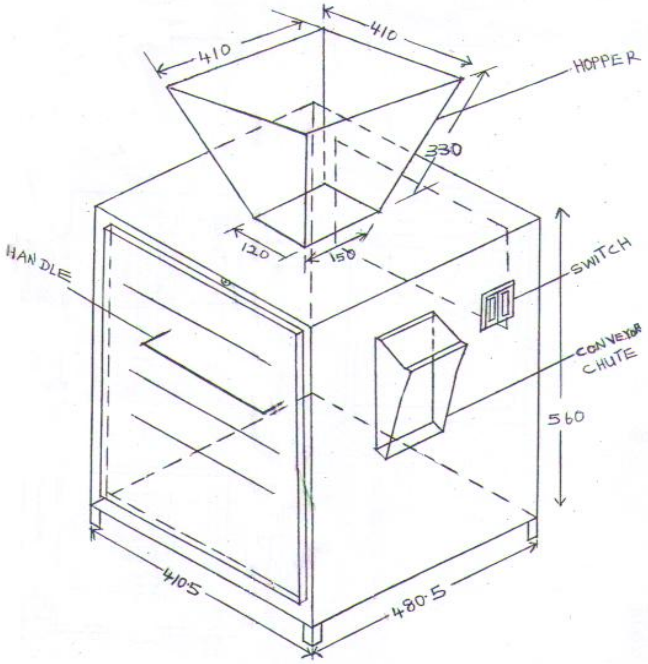

FIG 3a: ISOMETRIC DRAWING OF A MELON SHELLING MACHINE

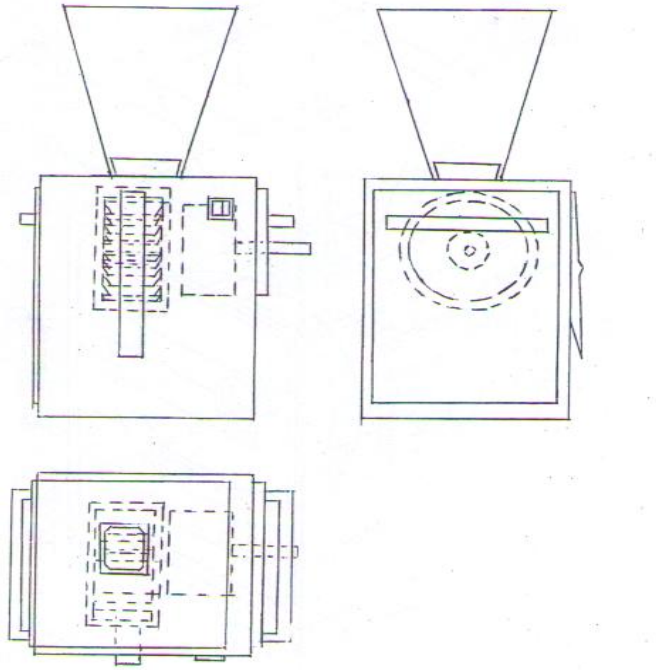

FIG. 3b: 1ST ANGLE ORTHOGRAPHIC DRAWING OF A MELON SHELLING MACHINE

(All Dimensions Are In mm)

E. *Assembling Of Parts*

After all the components have been fabricated, the following steps were taken to assemble the machine. The electric motor with a protruding shaft at one end was installed on the base made with 35.5mm flat bar and supported with 25mm square hollow pipe held together with a clamp. The next step was to fix the shelling drum on the base. The shelling drum was held or supported with a 25mm square

pipe welded to both the shelling drum and the base. The shelling drum houses the shelling disc which is fastened to the shaft protruding from the electric motor. Using manually operated arc welding machine, the hopper was welded to the shelling pot in such a manner that permits smooth flow of unshelled melon seeds into the shelling chamber. See fig4.

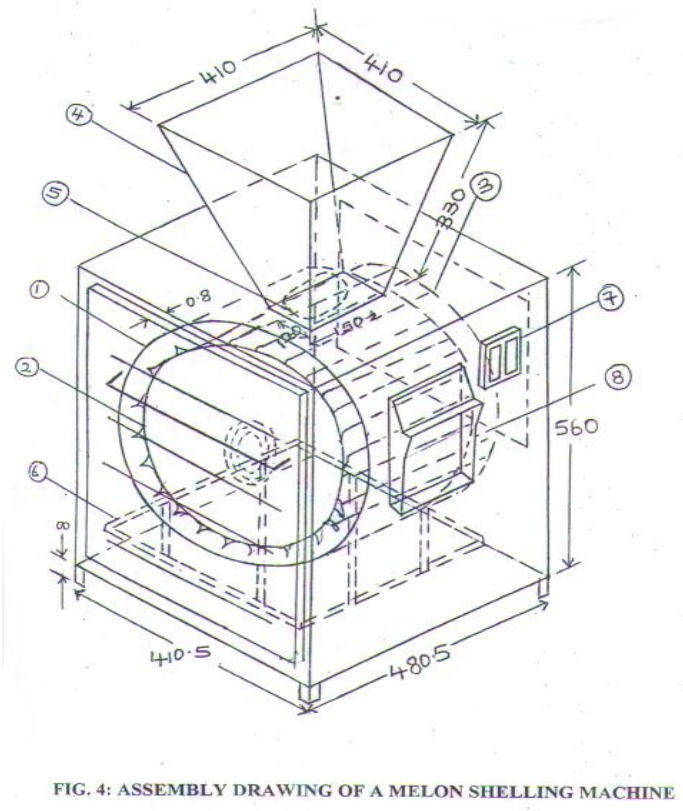

FIG. 4: ASSEMBLY DRAWING OF A MELON SHELLING MACHINE

(All Dimensions Are In mm)

TABLE 1: Part List Of An Improved Melon Shelling Machine

S/n	Description
1	Shelling drum
2	Shelling vane
3	Electric motor
4	Hopper
5	Small opening cover (lever)
6	Supporting base
7	Switch
8	Conveyor chute

F. Finishing Operation

All the parts welded were dislagged and thereafter polished to ensure a smooth finish. The polishing was done with a hand grinding machine. The next stage, was painting of the outside body with antirust followed by painting with a green coloured paint.

VI. DESIGN CONSIDERATIONS

A. Power Requirement

The total power required was calculated using the equation as specified by [21] and as cited by [14].

$P_T = P_{inner\ drum} + P_{shaft} + P_{shelling}$

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

Therefore, $P_T = P_{inner\ drum} + P_{shaft}$

But the shaft and inner drum are welded together, so

$P_T = P_{inner\ drum\ with\ shaft}$

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

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

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

N = is the number of revolution per minute of the inner drum with shaft =400 rpm

$T_{inner\ drum\ with\ shaft}$ = mass x acceleration due to gravity x radial distance

But Mass inner drum with shaft = 5kg,

Acceleration due to gravity = $10m/s^2$

Radial distance = 0.15m

$T_{inner\ drum\ with\ shaft}$ = 5 x 10 x 0.15 = 7.5Nm

$P_{inner\ drum\ with\ shaft} = 7.5\ X\ \frac{2\ X\ 3.142\ X\ 400}{60\ X\ 1000} = 0.3142KW = 0.4214Hp$

Using a power factor of 1.5, power required is 0.6321Hp, therefore an electric motor of 1Hp is selected to power the inner drum with shaft and shell the seeds.

B. Analysis Of Driven And Driving Pulley

Let:

N_1=Revolution per minutes of Driving pulley

N_2= Revolution per minutes of Driven pulley

D_1 =Diameter of Driving pulley

D_2= Diameter of Driven pulley

V_1= Speed in (m/s) of Driving pulley

V_2= Speed in (m/s) of Driven pulley

The diameter of driven pulley selected, D_2 =45mm

The ratio of the driven pulley outer diameter to that of the driving pulley outer diameter is 3.5:1

From the equation; $N_1D_1 = N_2D_2$

i.e $\frac{N_1}{N_2} = \frac{3.5}{1}$

Therefore $N_1 = 3.5N_2$

But N_1= 1400 rpm as seen on 1Hp electric motor

$N_2 = \frac{N_1}{3.5} = \frac{1400}{3.5}$ = 400rpm

Again from the equation; $N_1D_1 = N_2D_2$

$D_2 = \frac{N_1D_1}{N_2} = \frac{1400\ X\ 45}{400}$ = 157.5mm

To Obtain Speed Of Driving And Driven Pulley

$V_1 = \frac{\pi N_1 D_1}{60} = \frac{3.142\ x\ 1400\ x\ 45}{60}$ =3299.1mm/s =3.299m/s

$V_2 = \frac{\pi N_2 D_2}{60} = \frac{3.142\ x\ 400\ x\ 157.5}{60}$ =3299.1mm/s =3.299m/s

Since there is no slip $V_1 = V_2$= 3.299m/s

VII. RESULT AND DISCUSSION OF RESULTS

The performance evaluation of the melon shelling machine was carried out with 1hp (1400 rpm) electric motor. Unshelled melon seed were weighed, sprinkled with water and partially dried with natural air so that the skin coat became slightly softened so as to make shelling more efficient. The melon shelling machine was fed with different quantity of melon seeds and the shelling operation carried out in successions as shown in Table 4.1 below. The partially shelled, unshelled, broken unshelled and crushed were counted separately in the first, second and up to the fifth shelling operation respectively. The Tables 4.1 below shows the results of the experiment.

TABLE 2: Result Of Shelling Test Operation

S/n	weight of dry seed to be shelled (gm)	weight of completely shelled seeds (gm)	weight of unshelled seeds (gm)	weight of partially shelled and broken seeds (gm)	weight of crushed seeds (gm)	Efficiency (%)
1	70	60.9	5.6	3.0	0.5	87.0
2	140	131.6	5.0	3.0	0.4	94.0
3	210	203.0	4.0	2.7	0.3	96.7
4	280	273.7	4.0	2.0	0.3	97.8
5	350	344.4	3.5	1.8	0.3	98.4

$$\text{Average percentage performance} = \frac{87+94+96.7+97.8+98.4}{5}$$

$$= 94.78$$

TABLE 3: BILL OF ENGINEERING MEASUREMENT AND EVALUATION

ITEMS	QTY	TOTAL (₦)
1hp Electric motor	1	10,000
25mm Square tube	5100mm with 2mm thickness	1,000
37.5mm flat bar	3000mm length by 2mm thickness	1,000
Metal sheet	900mm x 1200mm x 3.5mm	6,000
Gauge 12 Electrode	1 packet	1,000
Body filler	4 litres	3,000
Steel rod Ø30mm	6000mm	3,000
Miscelaneous		14850
TOTAL		35,850

VIII. CONCLUSION

The melon shelling machine was made from locally available materials. It can be conveniently operated with little or no technical skill. Individuals can acquire it for domestic use and melon local farmers as well as medium scale industries involved in melon oil processing can also make use of the machine since it does not require high skill labour. The average percentage performance of the melon shelling machine was found to be 94.78%. The average percentage of unshelled melon seeds plus crushed melon seeds was 5.22%. The production cost was ₦35,850 which is cheap compared to the cost of the imported ones available in the market.

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REFERENCES

1. A.S. Adekunle, I.O Ohijeagbon and H. D. Olusegun. "Development And Performance Evaluation Of Manually And Motorized Operated Melon Shelling Machine Using Impact Techniques". Journal Of Engineering Science And Technology Review, 2(1): 12-17, 2009.
2. A.Y. Amadu: Improvement Trial Of Melon Seed Dehusking Machine. Unpublished B.Sc. Report, Dept. of Agric. Engineering, Samaru College Of Agriculture, Zaria, Nigeria,1981.
3. M. Babale: Fabrication Of An Egusi Shelling Machine. Unpublished B.Sc. Report Dept. of Agric. Engineering, Samaru College Of Agriculture, Zaria, Nigeria, 1988.
4. L. Denton and M.O. Adeiran :" Geographical Performance and Distribution of the Major Seed Types of Egusi". 10th Annual Conference of Horticultural Society of Nigeria. Pp 5-8, 1988.
5. I. Fadamoro :Design and Construction of a Manually Operated Melon Sheller, Unpublished B.Sc. Report, Department of Mechanical Engineering, University of Ilorin, 1999.
6. A.B. Fashina: The Design And Development Of A Melon Sheller. Unpublished B.Sc Project Report, Department of Agriculture, University Of Ife, Nigeria, 1971.
7. I.D. Kafi: Development And Trial Of A Dehusking Machine For Egusi Seed. Dept. of Agric. Engineering, Samaru College Of Agriculture, Zaria, Nigeria,1980.
8. K.M. Mohammed: Fabrication Of An Egusi Shelling Machine. Unpublished B.Sc Project Report, Dept. of Agric. Engineering, Samaru College Of Agriculture, Zaria, Nigeria, 1989.
9. D.S. Obienwe :Design, Construction And Testing Of An Electrically Powered Melon Sheller, Unpublished Project Report M. Eng. Thesis. Department Mechanical Engineering University Of Ilorin, Nigeria, 2002.

10. E.U. Odigboh:"Impact Egusi Shelling Machine", Transaction Of The *ASAE*, 22(5):1264-1269, 1979.
11. F.B. Okokon, E. Ekpenyoung, A.U. Okpobo:"Shelling Characteristics of melon seeds". *Journal of Food, Agriculture and Environmet*, Vol. 3(1) pg. 110-114.
12. C.B. Olayiwola: "Women in Agriculture", Paper Presented at the Workshop on Women in Development, Sponsored by *DFRRI*, Abuja, 14th -16th September. Pp 6-9, 1987.
13. H.D. Olusegun and A.S. Adekunle:The Design, Construction and Testing of Melon Sheller. *Global Journal of Engineering and Technology*, Volume 1, Number 4. Pg. 473-481, 2008.
14. O.O. Oluwole and A.S Adedeji: "Effect Of Moisture Content And Inner Drum Rotation Speed On The Shelling Performance Of A Melon Sheller". *Scientific & Academic Publishing*, 2012.
15. F.A. Oyawale And E.K. Adeniyi: "Design, Fabrication And Evaluation Of Melon Shelling Machine". *Journal Of Research In Engineering*, Vol 6, No. 1. Pp. 18-26, 2009.
16. A.N. Ringin, :Fabrication Of An Egusi Shelling Machine. Unpublished B.Sc. Report. Dept. of Agric. Engineering Samaru College Of Agriculture, Zaria, Nigeria, 1982.
17. O.O. Rotimi, Design And Construction Of Melon Shelling Machine Unpublished B.Eng., Project Work, Mechanical Engineering Dept. University Of Ilorin, Nigeria, 2006.
18. S.K Shittu, V.I.O. Ndrika, Development And Performance Test Of A Melon (Egusi) Seed Shelling Machine. Agric Eng Int: CIGR Journal, 14(1), 2012.
19. M. T. Ige: "Improved technology of processing melon Seeds", Transaction of *ASAE*, Vol. 20 pg. 1124-1126, 1982.
20. P. Oja: Constructuion of melon shelling machine, Unpublished B.Sc. Report. Dept. of Agricultural Engineering, University of Ilorin, Nigeria, 1991.
21. B.O. Akintunde, F.A. Oyawale, T.Y. Tunde-Akintunde: Design and fabrication of a cassava peeling machine. Nigerian Food Journal Vol. 23 pg. 231-238. 2005.