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CONSTRUCTION OF A DUAL POWER OPERATED CASSAVA GRATING MACHINE

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ABSTRACT - The Construction of a Dual Power Cassava Grater Machine which is an integral part of mechanization of Agricultural production, the design of a Cassava grating machine has two modes of operation was made. It can be powered manually which It takes care of power failure problems, and can be used in rural settlements where electricity supply is not in existence. A handle and the pulley all of which are attached to the shaft and it passes through the grating unit. It also consists of frame which gives it rigid support, four stands to suspend it above the ground. Cassava is fed with the Machine through the hopper made of metal sheet to the granting drum, which rotates at a constant speed. This process grates the cassava into cassava pulp. The chute constructed of metal sheet accepts the pulp and send it out because of its inclination which operated manually, the efficiency of the machine was found to be 92.4%. the machine is aim at increasing cassava production in both rural and urban areas where there is power supply or not. It productivity is 22kg/hr. and the machine cost ₦16,995 which can be affordable by local famers it is recommended that the cutting surface should be constantly brushed to avoid clogging and the bearing properly.

Keywords*: Cassava grating, Dual Power and Processing*

I. INTRODUCTION

Cassava is produced largely by small-scale farmers using rudimentary implements. The average landholding is less than two hectares and for most farmers, land and family labour remain the essential inputs. Land is held on a communal basis, inherited or rented; cases of outright purchase of land are rare. Capital is a major limitation in cassava production in the southwest Nigeria; only few farmers have access to rural credit (Oguntuase et al., 2015).

Cassava (Manihot esculenta Crantz) is a perennial vegetatively propagated shrub grown throughout the lowland tropics for its starchy, thickened roots. Global production of cassava amounted to about 278 million metric tons in 2018 out of which Africa's share was put at about 61% (FAOSTAT, 2020). The world's cassava production has been on the increase from about 240 million metric tons from the year 2010. In the same period, Nigeria alone produced about 42.5 million metric tons which is estimated to be about 18% of total global production. Nigeria's share of world production had risen to 21.5% of world production by 2018.

For many African countries, investment in irrigation for production of staple food grains is financially difficult. Cassava gives reasonable yield under marginal soil conditions and it is tolerant of drought (Kolawole et al., 2010). For this reason, it is rapidly overtaking maize and other food grains as an important staple food in many parts of Africa, stabilizing the food security status of the poor. However, cassava roots cannot be stored for too long. Cassava is best stored in the form of flour. High quality cassava flour (HQCF) can conveniently replace maize or wheat flour.

FAO projects that by the year 2025, about 62% of global cassava production will be from sub-Saharan Africa (FAOSTAT, 2020). Cassava is an important staple crop in sub-Saharan Africa (SSA). It is Africa's second most important food staple in terms of calories consumed per capita and a major source of calories for roughly two out of every five Africans (IFAD/FAO, 2005; Rosenthal and Ort, 2012).

The majority (88%) of cassava produced in Africa is used for human food, with over 50% used in the form of processed products (Westby, 1991; Oyewole and Eforuoku, 2019). Other uses in animal feed and for industrial purposes (starch, ethanol) are as yet very minor. Although the crop is considered as a staple in many countries, this situation is changing in some countries where cassava is now an industrial and cash crop (Reincke et al., 2018).

Cassava processing by traditional methods is labourintensive but the increasing application of improved processing technology has reduced processing time and labour and encouraged increased production. Industrial utilization of cassava products is increasing but still accounts for less than 5% of the total production (Shittu et al., 2016). To implement the second phase of the Cassava: Adding Value for Africa (CAVA2) Project, it became necessary to map the production and processing situation of cassava within the study area. This included the scoping of who the smallholder farmers were, which varieties are grown and the yield per hectare and average price of cassava roots.

Cassava processing by traditional methods is labour-intensive but the application of improved processing technology has reduced processing time and labour and encouraged further production. The productivity enhancing technologies promoted by the project included improved agronomic practices and adoption of improved and higher yielding varieties in production and efficient drying technologies for processing. (Agbetoye , 2006)

The aim of this paper is therefore to present the result of efforts made in producing a device that is used in granting. The transformation of cassava tubers into pulp form is called grating. Traditional tools used in Garri processing includes: Millstone, grinding stone, pestle and mortar. In these methods have low productivities and low hygienic solution to these problems that led to the designing and construction of machines that can grate the cassava of high quality in a short period of time and reduce human drudgery. Some of the machines include: roller crushing mill, hammer mill, bar mill and grater, all having one problem or the other.

Description and designed of the machine

The general consideration in designing this dual operational grating machine is producing a machine that can be easily assembled or disassembled, a machine in which the hopper allows materials to pass through effectively with minimum wastage; the grating drum is made of metal so as to increase its durability; the chute is sloppy to allow grating pulp to slide downward and get discharge by gravity.

Cassava grating machine grates the fresh peeled cassava tubers into fine paste which later processed into either gari or flour for human consumption. The machine is constructed with available materials to suit rural and Urban areas. The dual power operated cassava grating machine consists of hopper for which the cassava is fed into. It is supported on four stands. It also consists of a rigid frame structure that supports the whole machine. Bolted to the frame is the bearing housing which contains bearing at each side of the hopper through which a shaft is passed, then through the Batter cylinder for easy and smooth rotation. At the end of the shaft is a Pulley which is driven by the aid of the belt which passes round into the electric motor. During operation, the motor is transferred by a belt to the pulley which in turn drives the grater. The handle is attached to the shaft with a bolt and nut and is used when it is manually operated. Under the machine is the collecting box for collecting the grated cassava.

II. MATERIAL SELECTION

During selection of materials for machine consideration is given on components which have materials of acceptable properties which will be sufficient enough in terms of strength. durability and toughness that would enable it withstand some shocks, fatigues and reactions from other working components.

The materials are:-

Metal Sheet:-1mm mild steel meta sheet was chosen for the construction of hopper, grater cylinder and collection boy because of its ability to be welded by an arc or gas welding

Angle Iron:-1mm mild steel angle iron was chosen for its durability, toughness and it can withstand shocks, it is used for the machine stand.

Electric Motor:-200W Electric motor was suitable as it had suitable capacity to operate the machine.

Metal Pipe:-A hollow metal pipe was chosen for its hardness and durability to withstand shock. The handle, is used for turning the grater in a clockwise direction.

Plywood:-A 3mm thick plywood was chosen for the clearance between the hopper and the grater. It was chosen for its resistance to corrosion and rust.

Pulley: A V-grooved pulley of 60mm diameter was used to run the frater by an electric power transmitted from an electric motor through a belt.

Components and procedures

The order in which the fabrication was done include the following:

i. The Hopper: The hopper is constructed with 1mm thin mild steel sheet of 40mm by 150mm and the height of 800mm. it is measured with steel rule and cut with hacksaw. It is cut in a triangular shape and welded by an electric are welded machine. The hopper serves as reservoir in which the fresh peeled cassava tuber are fed which flows by gravity. The four triangular metal sheets that were cut and welded were inclined at 30^0 at the base.

ii. The Cylinder grater: The diameter of the grater is 40mm
   Grater = (22/7) D
   (22/7) x 40
   =125.7mm
   Therefore, the circumference of the grater = nD
   (22/7) x 40
   Width = 125.7mm
   The grater is made up of 1mm thick mild metal sheet which is measured 110mm by 125.7mm by a steel band and cut by a hack-saw. It is perforated by the use of a nail after which it is welded to a cylinder wood by an electric arc welding machine. The diameter of the wood is 125.7mm and the length is 110mm. the wood is drilled to a 12mm diameter where shaft of 160mm and a diameter of 25mm is passed through the cylinder wood, it is folded into a cylindrical form with a hole of 25mm diameter. It is wrapped and welded on a cylindrical wood, which is used to grate the incoming cassava from the hopper.

iii. The shift: A mild steel shaft of a length 160mm and a diameter of 14mm was used. It is standard steel band was used to measure the length and a hacksaw was used for the cutting. Both the pulley and handle are bolted to the shaft, which is used to turn the grater.

iv. The Collecting Box: A mild steel metal sheet of 1mm was measured and cut into 120mm length and width of

30mm at angles of 80^0 and 30^0. It was measured with a steel band and joined together by an electric arc welding machine. It is used to collect the grated cassava.

v. Electric Motor: A 200W electric motor is suitable to operate the cassava grater. The capacity is enough to turn the grater by an electric power generated from the electric motor to the belt to turn the grater during grating. This power is sufficient to operate the machine.

vi. The Stand: 1mm mild steel angle iron was chosen for its durable toughness and it can withstand shock. The angle iron is measured and cut into 8 section, 4 is used for the stand while 4 are used for the support. It has a length of 180mm and 90mm. it is measured with a steel band joined by an electric arc welding machine to form the stand. The hopper is bolted to the frame/stand. This is a rigid structure that supports the whole machine.

vii. Clearance Plate: A plywood of 3mm thick is used and a length of 900mm and 30mm. it is chosen for its resistance to corrosion and rust. It is bolted to the hopper. It can also resist wears because of its hardness.

viii. The Handler: A hallow mild steel of 85mm was used, it is folded and bolted to the shaft. The handle is used in turning the grater when it is manually operated.

ix. The Pulley: Pulley is used when it is electrically operated. A V-grooved pulley of 60mm diameter is used to turn the grater by an electric power from an electric motor through a belt. It is standard.

Table 1: Tools used for the Construction of the Machine

S/ N	COMPONENTS	SPECIFICATION (MM)	QTY	TOOLS USED
1 2 3 4 5 6 7 8	Hopper Collecting Box Shaft Grater Frame Handle Plywood (clearance)Plate Pulley	400 x 150 120 x 30 160 x 40 110 x 40 180 x 90 60 x 25 90 x 30 60 x 14	4 3 1 1 8 1 2 1	Hacksaw and arc welding machine Hacksaw and arc welding machine Hacksaw Hacksaw and nail welding machine Hacksaw and arc welding machine Electric welding Hacksaw Chisel Steel Band Standard

Figure 1.1: Dual Power Operated Cassava Grating Machine

Assembling

The components of the machine could be assembled to form a right body by the following procedures:

The frame (Stand) was constructed by welding the angle iron bars and two rollers bearing was bolted in its housing to the frame. The shaft is passed through the two bearing at each side to give easy and smooth turning during grating. The hopper which is designed through the materials is fed into the machine, which is bolted to the frame houses the grater. While the collecting box under the hopper is bolted to the frame which is used to collect grated cassava during grating. The two bearing are also bolted to the frame in their housing to protect the bearings from dust, sand and rust.

Operating principle

The machine is design in such a way as to make its operation simple. When mechanically operated, the machine is coupled to an electric motor by a V- belt pulley on the shaft. And when manually operated, the grating drum is set in revolution through the turning of the steering. Cassava is fed through the hopper and an additional plank is used to press the cassava on grater. The pulps are collected through the chute to the basin or directly on a cemented floor.

Performance test

Series of tests were conducted using the machine. Cassava tubers were obtained from a farm and peeled manually, thoroughly washed and weighed using weighing balance scale. The machine was operated for some minutes to allow speed to stabilize. Peeled cassava was introduced into it through the hopper. A piece of wood was used to press the cassava against the drum to prevent scattering of the cassava caused by machine vibration. The pulp was collected into a sac and taking to a press for dewatering. The dewatered pulp was weighed and recorded using the weighing balance scale. The pulp was then sieved. The weight of sieved and unsieved materials was recorded.

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III. DISCUSSIONS

The fabricated grating machine can be operated both manually as well as by electric power. It is therefore versatile and simple. The total cost of production of a unit is estimated to be about N16, 995.00 including both manufacturing and overhead costs. This is affordable for an average entrepreneur. The performance tests conducted indicated that high values of grating efficiencies are attainable when powered electrically and manually operated.

Testing

Measured quantities of peeled cassava were fed into the hopper and the machine was manually operated by running the handle. It was observed that its efficiently grated the cassava. Series of measured quantities were also introduced into the machine and they were efficiently grated with respect to time.

Table 2: Result from Series of Measured quantities of peel cassava

No. of Trials	Time (Mins)	Qty Fed in Kg	Qty Grated in Kg	Losses in Kg
1	10	3.2	2.8	0.4
2	10	3.5	3.3	0.2
3	10	5.6	4.8	0.8
4	10	2.4	2.2	0.2
5	10	3.6	3.4	0.2
6	10	4.0	3.6	0.4
6	60	22.3	20.1	2.2

Productivity of the Machine is given by:
P=Quantity/Time Taken
Trials one: 2.8kg/10mins = 0.28kg/min
Trails two: 3.3kg/10mins = 0.33kg/min
Trails three: 4.8kg/10mins = 0.48kg/min
Trails four: 2.2kg/10mins = 0.22kg/min
Trails five: 3.4kg/10mins = 0.34kg/min
Trails six: 3.6kg/10mins = 0.36kg/min
The Average = 0.28+0.33+0.48+0.22+0.34+0.36/6=0.34kg/min
Losses obtained after grating is per hour = 0.34kg/min X60/1 = 20.4kg/hour
Quantity Fed in = 22.3kg
Quantity grated = 20.1kg
Therefore, losses are = Quantity Fed in – Quantity Grated
22.3kg-20.1kg = 2.2kg
Machine working percentage performance = quantity grated/quantity fed in x 100
20.1/22.3 X 100 = 90%

The machine was operated manually and under normal turning. The quantity fed into the machine was 22.3kg. the quantity grated was 20.1kg and the loses obtained after the grating was 2.2kg. the productivity of the machine at the third gives 0.48kg.min or 21.8kg/hr, the machine working performance is 90%. Since the loses are not much, the machine can be used both in the urban and rural areas, especially in the rural areas to minimize the great losses they experience during cassava processing traditionally.

Both tests were conducted with 2.0kg of cassava. When manually operated, the grating efficiency was found to be 91.4%. That of electrically operated machine gave the efficiency of 90%. These levels of performances are satisfactory. They are even higher than that of pedal operated type (Ndaliman, 2006).

Table 3: Cost Analysis of the Machine

S/N	Components	Specification (mm)	Qty	Unit Price	Amount(N)
1	Frame/Stand	180 x 90	8	500	4000
2	Hopper/Box	400 x 150 x	1	2800	2800
3	Grater	120 x 30	1	800	800
4	Shaft	110 x 40	1	700	700
5	Bearing	160 x 14	2	350	700
6	Pulley	Standard	1	800	800
7	Handler	Standard	1	500	500
8	Plywood	60 x 25	2	600	1200
9	Bolts/Nut	90 x 30	13	15	195
10	Paints		2	150	300
11	Miscellaneous	Blue			5000
16,995					

IV. CONCLUSIONS AND RECOMMENDATIONS

The constructed grating machine has been found to be effective and efficient. It can be powered both electrically and manually. Therefore, it can be used by both rural as well as urban dwellers. It is also affordable since the cost of production is low. Efforts should be made to adopt and popularize this design, especially for the benefits of rural people who make up a greater percentage of the nation's population. It is also hoped that when mass-produced. The need to extend the use of cassava to gari processing in rural areas where there are sources of light is taken care of by this research. The machine if properly managed could generate revenue because many cassava growers will tend to bring their cassava for grating. If the labour is saved and production is increased and revenue increases the standard of living of the farmers will be increased. The machine is very affordable at the rate of ₦12,290 (Nigerian Naira).

V. RECOMMENDATIONS

The following recommendation should be considered

i. Ensure that all the nuts are properly tightened
ii. The bearing should be constantly lubricated
iii. There should be provision of wire brush to clean up the clogging from time to time during operation
iv. The machine should be cleaned after operation.

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