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DESIGN AND FABRICATION OF AUTOMATED YAM COOKING AND POUNDING MACHINE

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Abstract

This work is focused on the design and fabrication of automated yam cooking and pounding machine to perform the hygienic processing of pounded yam thereby eliminating the laborious process and also minimizing of time involved in processing pounded yam. The aim of this project is to design and fabricate a machine that will cook and pound the yam. During the design and fabrication of this machine, many factors were considered and these include cost of production, effectiveness of the machine, economic requirement and maintenance. The machine was fabricated using stainless steel, mild steel, pulleys, belt, bearing and shaft. A type A37 belt was used (v-belt), the depth of the bowl is 160mm, length, width and thickness of the beater is 73 x 30 x 3 mm. The cooking aspect and automated part of the machine includes; the heating element (electric heater), contactor, thermostat and timer. The diameter of the driving pulley is 150mm and the diameter of the driven pulley is 200mm. The test and performance evaluation of the machine was carried out at the University of Benin workshop. The result from the testing showed that the yam cooking and pounding machine produced a hygienic and well processed pounded yam in a lesser time. It totally eliminated the laborious process involved in pounding. The efficiency of the machine was 84.523% which is fair for a locally fabricated machine. Given that some percentage was lost due to the vibration from the motor.

Keywords: Yam, Cooking, Pounding Machine, Design, Fabrication, Automated
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1. Introduction

One of major tantamount desire of human beings is to search for better alternative in accomplishing a given task, most especially those tasks that are highly energetic and energy demanding in every facet of live. One of the keyed driving forces that better the existence of human beings is the replacement of human energy with machine such as pounded yam machine. This is one of the ways of eliminating human effort, through the development of Automated yam cooking and pounding machine. Yam is the oldest known recipes to man, it is a tuber crop which belong to the class of carbohydrates and has been a part of the African meal edible consumed as a meal in African countries. Yam is the common name for the species in the genius Dioscorea (family Dioscorea ceae). The sweet potato (ipomeas batatos) has traditionally been referred to as yam in part of the United States and Canada, but it is not part of the dioscorea ceae family. However, despite the importance attached to pounded yam specifically, majority of Nigeria homes still depend on traditional mortar and pestle method of pounding yam in which hygiene is not guaranteed and pounding efficiency are very low. Most times, the huge stress, time and energy consumption associated with this method of pounding discourage majority of the people from preparing pounded yam but rather, choose to consume it either cooked as yam slices and porridge, roasted as lumps, fried as chips and yam cake or cooked or even go for alternative methods of processing yam before consumption. Few years ago, development of yam pounding machines have been in progress in Nigeria. Some of the existing designed yam pounders failed due to some limitations in their operational functions. A few include; **Ordash and Ordiar (2008)** designed a pounding machine that beats using the process of cutting to pieces as well as crushing and turning to produce the natural taste. Yam is a daily nutritional food requirement for man and in order to facilitate the processing of yam for consumption, a yam pounding machine has been developed using mainly some locally sourced materials. The machine consists of a shaft, pulleys, belt, bearings, electric motor, yam beaters, bowl and the frame. The machine was developed to enhance the hygienic processing of yam for both domestic and commercial consumption, while eliminating the tedious process of preparing pounded yam. pounding machine. **Oweziem et al.,** (2010) focused on the design of an electromechanical yam machine consists of a shaft, electric motor, trough, propeller (yam beater), pulleys and the frame with vents for adequate cooling of the machine during operation. The maximum volume of yam pounded was gotten to be 6000000mm3 while a power requirement of 1 HP was needed to drive the machine. From experiment carried out in using the machine to pound three different species of yam, it was observed that irrespective of the improvement done on reducing overheating during pound, it pounds in less time compared to the already existing ones.

The primary aim of this study is to design and modify an existing yam pounding machine and to produce an automated yam cooking and pounding which cooks and pounds the yam in one chamber. The objectives are to modify a yam pounding machine in order to eliminate tedious and laborious indigenous process of preparing pounded yam. The automated yam cooking and pounding machine plays vital role as it helps in replacing drudged or stress initiated into human system after pounding has taken place, the machine will also help to the physically disable individuals as well as the aged to cook and pound yam, since less effort will be required in its operation. Another significant role this research plays is that, it will make ways for further research of the design and fabrication of yam pounding machine.

2.0 Methodology

2.1. Design Analysis

The Automated yam cooking and pounding machine consists of the following components (Fig 1 and 2): Electric motor is an electrical machine that converts electrical energy into mechanical energy which drives the pulley and belt system.

i. The pulley transmits power from one shaft to the other with the help of the belts. Proper selection of pulley diameter is important as the velocity ratio is the inverse ratio of the diameters of driving and driven pulleys.

ii. The yam beaters are two blades made of stainless-steel material and they are the main components that do the real pounding of the yam. These are two bars designed and joined together at angle 90° to each other at the center and they rotate together through angle 360° while pounding the cooked slices of yam.

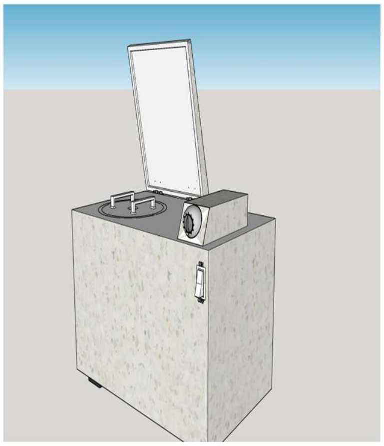

Figure1: Rendered view of the yam pounding machine

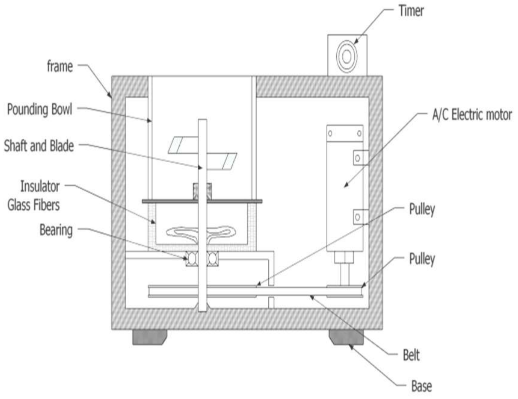

Figure 2: Sectional view of the yam pounding machine

Table 1: List of the Automated Yam cooking and Pounding machine parts

No	Part Name	No	Part Name
1	Electric Motor	7	Machine frame
2	Shaft	8	Contactor
3	Pulley	9	Timer
4	Belt	10	Thermostat
5	Yam Beaters	11	Electric heater
6	Pounding Bowl	12	Insulator

Certain calculations were made on certain parameters so as to make correct choices in selecting them. The mechanism of the machine was designed as follows:

2.1.1. Pulley analysis

For the belt to travel in a line normal to the pulley faces, the pulley must be perfectly aligned with each other. The speed of the motor is 1450rpm. In order to get the speed that would be transmitted to the shaft, the following analysis were been carried out:

$$N_1D_1= N_2D_2 \qquad (1)$$

Where: N_1 = Speed of motor, 1450rpm, D_1 = Diameter of driver, 50mm, D_2 = Diameter of driven, 250mm, N_2 = Speed of shaft

$$D_1N_1 = N_2D_2 \qquad (2)$$

$$N_2 = \frac{D1N1}{D2} = \frac{50\times1450}{250} \qquad (3)$$

$N2 = 290$rpm

2.1.2. Belt Design & Selection

Power is transmitted from the driver pulley to the belt and from the belt to the driven pulley. Friction between belt and pulley surface limits the maximum power that can be transmitted. If this limiting value is exceeded, belt starts slipping.

During selection process we employed the use of V-belt because of its high power transmission capacity and smooth and quiet operation.

The center distance C between the pulleys is gotten from;

$$C = \max\left(\frac{3D1}{2} + \frac{D2}{2}\right) \qquad (4)$$

$$= \max\left(\frac{3X50}{2} + \frac{250}{2}\right) \qquad (5)$$

= 200mm

The groove angle of the pulley

$$\mathrm{Sin}\beta = \frac{R-r}{C} \qquad (6)$$

$$\beta = \sin^{-1}\left(\frac{R-r}{C}\right) \qquad (7)$$

$$R = \frac{250}{2} = 125\text{mm} = 0.125\text{m} \qquad (8)$$

$$r = \frac{50}{2} = 25\text{mm} = 0.025\text{mm} \qquad (9)$$

$$\beta = \sin^{-1}\left(\frac{0.125 - 0.025}{0.2}\right) \qquad (10)$$

$\beta = 30^0$

Length of belt

$$L = \pi\frac{(D1+D2)}{2} + 2C + \frac{(D1+ D2)^2}{4C} \qquad (11)$$

$$= \pi\frac{(50+250)}{2} + 2(200) + \frac{(50 \quad 250)^2}{4(200)} \qquad (12)$$

= 983.74mm

A standard belt is then chosen as the nearest match is 1026mm which is type A43 belt

Angle of wrap

$\alpha_1 = 180 - 2\beta$ (13)

$= 180 - 2(30) = 120^0$

$\alpha_2 = 180 + 2\beta$ (14)

$= 180 + 2(30) = 240^0$

Tension on tight side of belt T_1;

$T_1 = btS_s$ (15)

$b = 12mm$, $t = 8mm$, $S_s = 3.0$ Mpa

$T_1 = 0.012 \times 0.008 \times 3 \text{ x } 10^6$

$= 288N$

Torsion on the slack side $T_{2;}$

$2.3 \log\left(\frac{T1}{T2}\right) = \mu \Theta \text{Cosec}\beta$ (16)

Θ is taken as the smallest of α

$\mu = 0.25$

$2.3 \log\left(\frac{288}{T2}\right) = 0.25 \text{x} 120 \times \frac{\pi}{180} \text{Cosec} 30^0$

$T_2 = 182.7N$

Power transmitted through belt:

$P = (T_1 - T_2)\, V$ (17)

$= (288 - 182.7)\, \frac{\pi \times 1450 \times 50}{60}$

$= 535.829W$

2.1.3. Bearing Design

A pillow block bearing was used because of itself contained, greased, sealed and ready for installation on the equipment. Pillow bearing support shafts that row parallel to the mounting surface. The diameter of the bearing is 1 inch. The specific static load rating C_o (Arvid, 1945).

$C_o = \frac{1}{5} K_o \times i \times z\cos\alpha D_w^2$ (18)

Where, C_o = specific static load rating, K_o = bearing factor, D_w = diameter of the ball

α = nominal angle 25^0, i = number of rows of ball in anyone bearing = 1 (Khurmi and Gupta, 2005), D_w = diameter of the ball, Z = number of balls per row = 6

$K_o = \frac{RA}{D} = \frac{633.21}{25.4} = 24.9$

R_A = bearing load = 633.21 (from shaft analysis)

$D_w = \sqrt{\frac{Co\ X\ 5}{Ko \times i \times z\cos\propto}}$

$= \sqrt{\frac{1000 \times 5}{24.9 \times 1 \times 6 \times \cos 25}}$

$= 6.08mm$

Then the maximum bearing load Q_{max}:

$Q_{max} = K_o \times D_w^2$ (Arvid, 1945) (19)

$Q_{max} = 24.9 \times (6.08)^2$

$= 920.5N = = 0.9KN$

2.1.4. Design of Shaft

Shaft design consists primarily of the determination of the correct shaft diameter to ensure satisfactory strength and rigidity when the shaft is transmitting power under various operating and loading conditions.

$$M_t = \frac{63000 \times hp}{rpm} \tag{20}$$

$$M_b = T_1 - T_2 \tag{21}$$

M_t = torsional moment, M_b = bending moment, T_1 = tight side of belt, T_2 = loose side of belt

$$M_t = \frac{63000 \times 1h}{290}$$

N_2 = 290 rpm (the pulley that hold the shaft)

$M_t = 217.4$

$M_b = 105.3$

According to ASME code equation

$$d^3 = \frac{16}{\pi Ss}\sqrt{(KbMb)^2 + (KtMt)^2} \tag{22}$$

K_b = Combined shock and fatigue factor applied to bending moment

K_t = Combined shock and fatigue factor applied to torsional moment

$K_b = 1.5$, $K_t = 1.0$, $S_s = 8000$ (Schaum's outline)

$$d^3 = \frac{16}{\pi Ss}\sqrt{(KbMb)^2 + (KtMt)^2}$$

$$d^3 = \frac{16}{\pi(8000)}\sqrt{(1.5 \times 105.3)^2 + (1.0 \times 217.4)^2}$$

d = 12.17mm

2.1.5. Blade Design

Length, L = 140mm, Width, W = 60mm, Thickness, T = 8mm

$$V = L \times W \times T \tag{23}$$

$= 0.14 \times 0.06 \text{ x } 0.008$

$= 0.0000672m^3$

Density of stainless steel, $\rho = 7500kg/m^3$

Mass = density x volume

$= 7500 \times 0.0000672$

$= 0.504kg$

Weight, $W_b = mg$

$= 0.504 \times 9.8$

$= 4.9N$

The weight of the beater is 4.9N

Area of beater surface in contact with yam:

$$A = \frac{1}{2}(a + b)h \tag{24}$$

$= \frac{1}{2}(0.03 + 0.026)(0.08)$

$= 0.0024m^2$

Volume occupied by beater:

$V = At = 0.0024 \times 0.005 = 0.000012m^3$

Effect of yam on the beater:

A piece of yam with dimensions L=40mm, B=40mm, H=40mm is used for this analysis.

Volume of yam piece = $(40/1000)^3 = 0.0000046\ m^3$

Density of boiled yam: 1950kg/ m^3

Mass of the piece of yam:

$$\rho \times v = 1950 \times 0.000064 = 0.1248kg$$

There can be a maximum of two (2) pieces of yam on the beater, hence

$$\text{Mass of 2 pieces of yam} = 2 \times 0.1248 = 0.2496kg$$

$$\text{Weight of 2 pieces of yam} = 0.2496 \times 9.81 = 2.449N$$

Total weight of beater with yam on it:

$$\text{Total weight} = \text{weight of beater} + \text{weight of 2 pieces of yam}$$

$$\text{Total weight} = 0.942 + 2.449 = 3.391N$$

Determination of crushing pressure and force acting on beaters surface

$P = \frac{F}{A}$; $F = P_y \times A$ (25)

$P_y = \rho_b gh$ (26)

Where P_y = Crushing pressure, h = height of the yam.

The machine is designed to pound an average of tuber of yam. Experimentally, a tuber was cut into pieces of 40mm cube, into a total of 22 pieces.

$$P_y = 1950 \times 9.81 \times 0.051 = 975.6N/m^2$$

$$F = 975.6 \times 0.0024 = 23414.4N$$

To crush 22 pieces of yam by RHS of beater; $F = 2.34144 \times 22 = 51.5N$

Turning Effect and Power Requirement:

Torque Computation: $F = T \times D$ (27)

Where T = Torque, F = Force, D = Distance from center of pivot

Torque from weight of beater with yam weight inclusive

$$T = 2.34 \times (0.04 + 0.0125) = 0.1779755Nm$$

Torque from force acting on the surface of the beater

$$T = 40.4008 \times (0.04 + 0.0125) = 2.121Nm$$

Torque of RHS of beater = 0.177975 +b2.121 = 2.299Nm

Total Torque of beater = $2 \times 2.299 = 4.598Nm$

Power Requirement:

This is given as: Power(P) = $\frac{2\pi N}{60}$ (28)

Where N =speed of revolution and T = Torque

Using a speed reduction factor of 1:3; $N = \frac{Motor\ speed}{3} = \frac{1440}{3} = 480$rpm.

$P = \frac{2 \times \pi \times 480 \times 4.598}{60} = 231.121$ Watts

Hence considering the factor of safety 1.5, the minimum power requirement for the design;
= 231.121 × 1.5 = 346.681. Therefore, based on the above calculations an electric motor of 1hp with speed 1440rpm, phase 3 and voltage of 440V was chosen.

2.2. Material Selection

In selecting material for a component, the following factors must be considered cost of production, availability of material, physical and mechanical properties of each parts of the machine, function of components part and its suitability and ability to be easily worked on. This was so because the automated yam cooking and pounding machine consists of components such as Electric motor, pulley, belt, thermostat, timer etc.

2.2.1 Machine Frame

The machine frame was made of stainless steel material and screwed to an angle bar that was joined by welding process.

2.2.2 Belt drive (Pulley and Belt)

The diameter of the main shaft was 250mm while the diameter of the driving pulley is 150mm and the diameter of the driven pulley is 200mm. A belt was used to transmit power from one shaft to another by means of pulleys which rotate at the same or different speed. A type A37 V-belt was used and it was made of rubber.

2.2.3 Electric Motor

The electric motor was selected based on the calculated power required to power the machine. The specifications on the electric motor are shown in the table below:

Table 2: Power requirement of electric motor

Description	Value
Power	1hp
Frequency	50Hz
Speed	1440 rev/min
Voltage	220V

2.2.4 Bearing

The bearing used was based on the diameter of the shaft. A pillow block bearing was used because of itself contained, greased, sealed and ready for installation on the equipment. Pillow bearing support shafts that row parallel to the mounting surface. The diameter of the bearing is 1 inch.

2.2.5 Shaft

The shaft of this machine was designed mainly with the use of a stainless steel material. Stainless steel material was used because of its very high resistance to corrosion and workability

2.2.6 Pounding Bowl: The pounding bowl is a stainless steel structured bowl which consists of the yam beaters which perform the pounding operation in a chamber of the bowl.

2.2. Analysis of the Automated Part /Cooking Element of the Machine

2.3.1 Electric Heater (cooking element):

The electric heater is made up of heating core radiator that heats up when the electric current enters into the device. The electric heater converts electrical energy directly to heat energy. The heating element was placed directly under the pounding bowl, since the bowl served two purpose (for cooking of the yam and also pounding of the yam). The rating for the heater used was 1,500 watts.

2.3.2 The Heater Design

The total heat required, (Q_T) is the energy required (excluding the wastage due to radiation/convection, etc.) for the cooking of yam tuber. Note, in this calculation, we have neglected the heat loss by air-convection/conduction and assumed that there was no heat loss from the bottom surface of the pot in contact with the heating element. The total heat required to cook yam was determined as described by (De *et al.*, 2014).

Total heat required (Q_T) = minimum or sensible heat required to cook yam (Q_Y) + heat required to heat the pot (Q_P) + latent heat of evaporation (L_V) + Heat loss from the wall of the cooking pot (Q_L).
Minimum Heat required to cook yam (Q_Y)

$$Q_Y = m_y C_y (T_{mi} - T_a) \tag{29}$$

Where; m_y = mass of yam, C_y= specific heat capacity of yam
= 2.056 kJ/kg°C (Oke et al., 2008)
T_a = initial or ambient temperature of the pot, T_i = inside wall temperature of the pot
T_s = mean steam temperature, T_{mi} = mean internal temperature
$= \frac{Ti + Ts}{2}$
Heat required to heat the pot (Q_P)

$$Q_p = m_p C_p (T_{mp} - T_a) \tag{30}$$

Where; m_p = mass of yam
C_p = specific heat capacity of pot = 502.416 J/kgK
T_p = outside wall temperature of the pot

$$T_{mp} = \text{mean wall temperature of the pot} = \frac{Tmi+Tp}{2} \tag{31}$$

Latent heat of evaporation (LV)
Latent heat of evaporation = $\Delta m L_v$

Where L_v = latent heat of vaporization (2.26×10^6 J/kg)
m_f = mass of yam plus water and lid closed at the time t of cooking
m_i = initial mass of yam plus water and lid closed at the time of putting on the heater
$\Delta m = (m_f - m_i)$ amount of water lost by evaporation.
Heat loss from the wall of the cooking pot (QL)
Heat loss from the wall of the cooking pot was determined as described by (Earle and Earle, 2004)

$$Q_L = h_c A_c (T_p - T_a) \tag{32}$$

Where h_c = the heat transfer coefficient at the outer surface
A_c = curved surface area of the pot
Thus, the power required to power the heater of the improved electro-mechanical yam pounding machine was determined as described by (Hussein et al., 2017).

$$\text{Power} = \frac{\text{total heat required}}{\text{time of pounding}} \tag{33}$$

Based on the above calculations, a heating coil element of 1.5KW power was chosen for use.

2.3.3 Contactor:

A contactor is an electrically controlled switch used for switching an electrical power circuit. A contactor is typically controlled by a circuit which has a much lower power level than the switched circuit, such as a 24-volt coil electromagnet controlling a 230-volt motor switch. The contactor powers/ signals the electric motor to start running immediately the cooking process is done.

2.3.4 Timer:

A timer is a specialized type of clock used for measuring specific time intervals. For the automated yam cooking and pounding machine the timer is set to the time that it will take a normal gas cooker to prepare that quantity of yam that is put into the machine.

2.3.5 Thermostat:

A thermostat is a regulating device component which senses the temperature of a physical system and performs actions so that the system's temperature is maintained near a desired set point. Using this machine to boil the yam, we will need to heat water to its boiling point which is around 100 degrees Celsius (212 degrees Fahrenheit) at sea level. Now, the temperature of the yam itself will start at room which is 20^0c and it will increase as it absorbs heat from the boiling water until it reaches the boiling point of water, which is 100^0c.
Let's assume:
Specific heat capacity of yam, c = $1.34 J/g^0c$
Initial temperature, $T_i = 20^0c$ (room temperature)
Final temperature, $T_f = 100^0c$ (boiling point of water)
Mass of yam, m = 1kg =1000g
First we calculate the change in temperature:

$$\Delta T = T_f - T_i \tag{34}$$
$$= 100^0c - 20^0c = 80^0c$$

Now, we can use the formula:

$$Q = mc\,\Delta T \tag{35}$$

Substituting the values:

$$Q = (1000g) \times (1.34\ J/g^0c) \times (80^0c)$$
$$Q = 107200J$$

So, the heat required to boil 1kg of yam is approximately 107200J.

3.0. Mode of Operation

The Automated yam cooking and pounding machine is a simple machine that can be operated. After the assembling of the component parts of the machine, it is then operated electrically by a shaft operated by an electric motor of one horse power. The machine is switched on by plugging it to a circuit. Since it's a cooking and pounding machine the cooking element of the machine has to function first. So after switching on the machine the automated part of the machine has to be set in order to avoid any further interruption of the machine working process. The Timer is set to the calculated time it will take to cook the Quantity of yam been put into the yam bowl, then the regulator (Thermostat) is set to a particular temperature that is required to cook the yam. The heating element (Electric heater) is directly under the pounding bowl, immediately the automated part is being set the cooking process begins. After the cooking process is completed the timer and cooking element automatically trips off, then the contactor signals (powers) the electric motor. When machine is switched on the speed of the electric motor is transmitted to the pulley via the V-belt and then to the shaft, which rotates the yam beaters thereby bringing about the pounding process.

3.1. Maintenance

Proper maintenance of the machine is important in order to keep the machine in a good working condition whenever it's to be operated.
For the automated yam cooking and pounding machine periodic maintenance of the components is very necessary. The process of maintenance of the machine can be carried out as follows;

- Cleaning of the yam pounding chamber when not in use by disassembling of the yam beater from the yam pounding bowl and then clean the inside thoroughly.
- Lubricating of the rotating shaft and greasing of the moving components
- Check the belt tension when carrying out maintenance
- By turning off the regulator after use

3.2. Cost Analysis

The designing of the machine, cost in procuring the items used in producing the machine played a vital role. A well designed machine may fail economically if cost is not taken into consideration. The total cost of the machine was ₦128,300 and the details are shown in Table 3 above

Table 3: Bill of Engineering Measurement and Evaluation

S/N	Parts Name	Material	Quantity	Component Dimension	Cost of unit (Naira)	Total cost (Naira)
1	Electric Motor	Purchased	1	1hp	45,000	45,000
2	Shaft material	Stainless steel	1	25mm, l=250mm	6,500	6,500
3	Pulley		1	200mm	5,000	5,000
4	Belt drive	Rubber	1	A37	2,500	2,500
5	Yam Beaters	Stainless steel	-	73 x 30 x 3mm	-	2,500
6	Pounding bowl	Stainless steel	1		5,000	5,000
7	Machine frame	Angle bar	1 full length	1inch by 1inch angle iron	4,000	4,000
8	Bearing	Mild steel	1	-	1,500	1,500
9	Welding electrode	Purchased	20,20	-	-	3,700
10	Thermostat	Purchased	1	-	-	5,000
11	Electric heater	Purchased	1	1,500watt	-	3,000
12	Contactor	Purchased	1	-	-	7,000
13	Timer	Purchased	1	-	-	3,000
14	Spraying	Purchased	2 cups	-	1,300	2,600
15	Electric cord	Purchased	-			2,000
16	Labour	-	-	-	-	30,000
	Total	-	-	-	-	**128,300**

3.3. Performance Evaluation

After assembling all the working parts including the automated part of the machine (shaft, bearings, pulleys, electric motor, V-belt, yam beater, machine frame, pounding bowl, electric heater, contactor, thermostat and timer) that makes up the automated yam cooking and pounding machine. The performance of the machine was tested by cooking and pounding two different species of yams (white yam and water yam), The test was carried out in Production workshop of the University of Benin. In each case, the yam specimen was washed, peeled, cut into small slices and put into the bowl. The timer is set for each type of yam for the heating element to cook the yam. For the white yam the timer is set for 35minutes and 25minutes for the water yam. Once the set time is achieved the heating element trips off and the contactor powers the electric motor for the pounding to takes place. The test carried out shows that the machine is functional and the results are shown in Table below;

Table 4: Pounding different yam specimen

S/N	YAM SPECIMEN	POUNDING TIME (MIN)	TEST FOR HARDNESS TIME (MIN)	TOTAL POUNDING TIME (MIN)	TEXTURE OF YAM
1	White yam	5	1	6	Starchy
2	Water yam	4:15	1	5:15	Semi-Starchy

It was discovered that it took the white yam 30 minutes to cook and pound while the water yam takes 20 minutes to cook and pound. From the results of the test carried out it was equally observed that the indigenous and laborious process of preparing pounded yam was completely eliminated.

3.3.1 Pounding Efficiency

After pounding, both yams were weighed which gave us 2.4kg for the white yam and 2.0kg for the water yam. The pounding efficiency can be determined by dividing the mass of the pounded yam by the initial mass of the yam multiplied by 100. Since we have two yam specimens we use the formula for both yam specimens and find the average efficiency.

$$\text{Pounding efficiency} = \frac{mass\ of\ the\ pounded\ yam}{Initial\ mass\ of\ the\ yam} \times 100\%$$

For white yam,

$$\text{Pounding efficiency} = \frac{2.4}{2.8} \times 100$$
$$= 85.714\%$$

For water yam,

$$\text{Pounding efficiency} = \frac{2.0}{2.4} \times 100$$
$$= 83.333\%$$

$$\text{Pounding efficiency of the machine} = \frac{85.714 + 83.333}{2}$$
$$= 84.523\%$$

The pounding efficiency of the machine after calculation was gotten as 84.523% which is fair for a locally fabricated yam pounding machine.

4.0. Conclusion

An attempt was made to produce an automated yam cooking and pounding machine which was designed, fabricated and tested. Compared to the indigenous method, we were able to minimize the time taken in processing the cooked and pounded yam. With the minimized time we were able to produce pounded yam with a nice texture. Producing this machine on a large scale will provide an opportunity for making pounded yam in large quantities with reduced time of processing and also reducing the cost of labor for restaurants and canteens. Performance test and evaluation revealed that the yam cooking and pounding machine was fabricated with an efficiency of 84.523%. Also, the issue of overheating which was a problem in previous prototypes was totally eliminated in this machine by creating a vent in the chamber of the electric motor making the motor cool itself by the speed generated.

Conflict of Interest

There is no conflict of interest associated with this work.

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