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DESIGN OF MILLET POUNDING MECHANISM

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ABSTRACT
The design of millet-pounding machine is to replace the traditional methodof pounding at remote areas. It wasfound that, most of the rural people are still using a traditional mortar and pestle to pound the millet and other grains, ultimately resulting in the wasteof time and physical exhaust.If there is a pounding machine,at least they have time to engage their pounding time for other essential works. Besides, it requires two persons to engage for pounding of grains and has probability of direct contact of body sweats and dust into the millet pounded. The designed machine comprises of an electric motor, beater, v-belt, trough, frame and two different sizes of pulleys. It is operated by an electrical driveto generate the reciprocating motion from rotary motion. It converts rotary motion to reciprocating motion by belt between two pulleys, where it actuates the rocker armsand cams simultaneously. The design has improved based on the growth of agricultural products, to ensure hygiene, minimize the workforce and lessen the operating time.

Keywords: traditional, affordable, motorized, workforce, generate

INTRODUCTION
The improved design work towards resolving the problems faced during pounding of grains. Duringforefathers' time the pounding of millet with the pestle and mortar is a special way of producing the millet.Motor made of wooden having one or more shallow pockets to pound by means of a round, long wooden log of 5ft-6ft called pestle. Today, with the advancement technology and innovative ideas, most of the machineries aremotorized, but expensive. However, people inrural areas are not able to effort for the motorized machine due to financial constraint. Therefore, most of the farmers are compelled to employ the traditional method, although it is inefficient, time consuming and exhausting process. Thus to mitigate the mentioned problems at the basic level and minimize the cost of product, it has been improved the design so that every household could easily avail it.

BACKGROUND
In general, most of the farmers spent much time and effort for grinding of agriculture productsfor their consumptions as well as for the commercial purposes. It was observedthat most of the agricultural productsare not consumewithout grinding or food processing.Agricultural product like millet, which is a cereal crop plant belonging to the grass family, Graminae. The term "millet" is used loosely refer to several types of small seeded annual grasses [1].It also reflected as one of the underutilized groups of cereal grains, it ishigh nutritional and nutraceuticals components, but these are still considered as food of poor people. The researchers reported that the millet presence of dietary fiber and phenolic compounds help preventfrom many diseases such as diabetes, cardiovascular diseases, and cataracto-genesis.Indeed, millet will hydrate the colon to keep us from being constipated and it render to demand as health and food security reasons in Asia[2]. In other sides there are certain factors affects the growth of millet like climate changes, water scarcity, increasing world population, rising food prices, and other social economic impact that threat to agriculture and food security worldwide, especially for the

poorest people who live in arid and sub arid regions[3]. The demand of millet product is still increasing due to growth of population, as a reason it has come up with designsof an automated millet milling machineaimingto produce efficient powdered in large scale[4].

LITERATURE REVIEW

A. O. Odior &E. S. Orsarh, (2008) "Design and Construction of a Yam Pounding Machine" the authors designed pounding machine using locally source materials to yield better homogenous bonded yam. It has been carried to enhance the hygienic processing of yam for both domestic and commercial consumption. The designed machine consists of shaft, pulleys, belt, bearings, electric motor, yam beaters, bowl and the frame.However, it observed that the designed machine was operates at very high speed, which is not adequately ventilated due overheating of the electric motor as a result it decrease the life of machine[5].

Osueke Christian Okechukwu (2010) "Design and Construction of a Yam Pounding Machine"the author improved the design of pounding machine assimilatedwith mild steel and galvanized sheet based on its material availability, strength, appearance, cost, and corrosion resistance. The machine was designed base on the volume of yam to be pounded and power required to drive themachine [6].

Oweziem Bright Uchenna et al (2015)"Design, fabrication, and characterization of an electrically powered yam pounding machine". The team focused on designing of an electromechanical yam-pounding machine. It consists of shaft, electric motor, trough, propeller (yam beater), pulleys, and the frame with vents for adequate cooling of the machine during operation.However,the design improvement was made upon overheating of electric motor during operation by creating vents to adequate cooling, improvement on size, increase damperelements to minimize vibrationsand working efficiency[7].

G. A. Ikechukwu & M. J. Muncho (2015) "A Motorized Yam Pounding Machine Developed to Improve Living Standard of Average Nigeria for Sustainable Economic Growth". The design of motorized yam-pounding machine were considered as essential in Africa particularly at Nigeria to replace traditional mortar and pestle method, which consume time and energy. Many researchers have been work towards eliminating the labors involved in traditional method of pounding. The development work sought to enterprise a yam pounder right from the peeled cooked stage in a pounding vessel with help of electric motor. The design consists of shaft, electric motor, yam beaters or pounding blades, bowl and the frame. It used cheap materials to fabricate the machineto easy affordable for Nigerian homes, thereby improve the living standard[8].

Onuoha Solomon. Net al (2019) 'Design, Fabrication and Testing of Yam Pounding Machine'. The yam product is the delicacy itemranked topmost in typical Nigerian menu lists. The design and fabricationwere to improvedtime and energy consumption accompanying traditional method of mortar and pestleconsidering on factor of safety, hygiene, cost and availability of materials in the market. Its design was found satisfactory, households and restaurant operators with comfortfor pounding yam [9].

CREATING THE CONCEPT DESIGN

Design of pounding machine involves concept design, development of AutoCAD (software) and design analysis. Initially it starts with concept design based on a prerequisiteat different places and its agricultural products. Thereafter, draft a rough sketch mechanism for the final processing.It has improvedsize of machine to minimize the price of a product. The designalso taken into consideration the existing machines available in the market which is very expensive.

TWO DIMENSIONAL DESIGN DRAWING

The figure 1 Illustrate the orthographic views of mechanism, which describes true size and shape of the features. It obtained entire aspect dimensions of a product for the fabrications.Whereas in 3D model simply it depicts the product and will not suffice in the process of developing products. It used AutoCAD software to design the product.

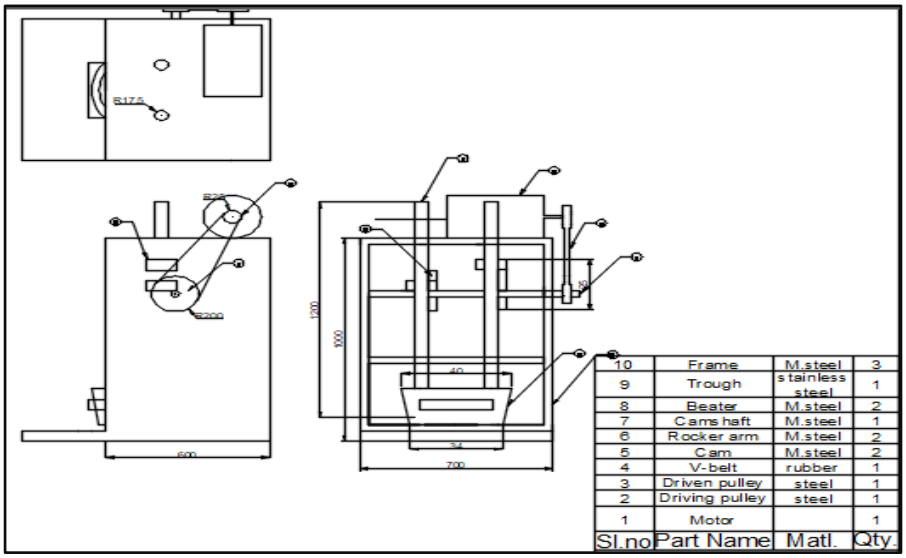

Figure 1: Multi Views of ImprovedPounding Machine

ASSEMBLED 3-D DESIGN

It is essential to design a3-D model to reveal its real imagination and reinstate presentation of the architecture drawing. It also shows the overall figure and its features component of a product as shown in figure2.

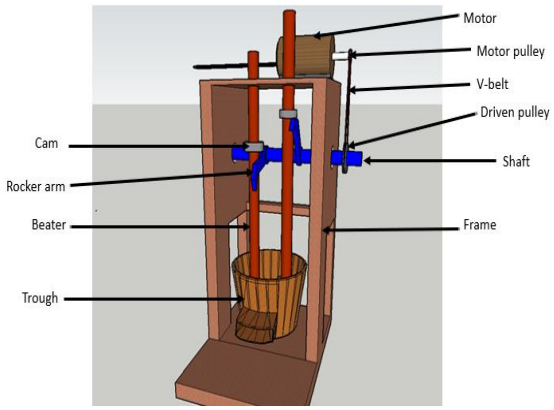

Figure 2: 3-D model of Improved Pounding Machine

DESCRIPTION OF COMPONENTS

1. AC Motor

It is a primary source of energy to operate the designedmechanism. In which, the rotary motion of its shaft transmits power to the driven shaft through v-belt.

2. **Pulleys**

The pulley is to accommodate the belt by its V-groove and transmits power from a driving pulley to the driven pulley. The driving pulley is smaller than the driven pulley.

3. V-Belt

In this designed, it preferred V-belt to transmit power due to short distances between the two pulleys. It creates maximum contact surface to develop friction between the rims of the pulleyand will enable smooth power transmission.

4. **Rocker Arm**

The rocker arm works in rotary lever to actuate the beater into reciprocating motion. The rocker arms were set at 90 degrees to each otherto provide alternate motions to the cam on the beaters (Vertical shafts).

5. **Beaters**

A beater is a cylindrical rod made of mild-steel to movesback and forth in the vertical direction. It provides hammering action to the millets contained in the trough. It has cam mounts on its periphery.

6. **Cam**

It is a cylindrical ring attached to the beater on its periphery to seat the rocker arm for contact. The contact of a rocker arm and cam will reciprocate the beaters in vertical direction.

7. **Trough**

A trough holds the grains to be pound. It is the areas where the actual pounding operation takes place. The shape of a trough designed in frustum of the cone. The base of the trough is smaller as it moves higher.

8. **Machine Frame**

The machine frame is to hold the components. It also withstandsforces and shocks generated during the pounding operation.

WORKING MECHANISM

The machine operates on rotary motion to reciprocating motion to complete the pounding action. Electrical energy is supplied to single phase AC motorwith a speed of 500 r.p.m to transmit the power to the driven pulley via V- belt. The diameter of a motor pulley and the driven pulley will considerably the speed ratio (reduce). The speed reduction ratio use 10:1 in motor to the drivenshafts to generate new r.p.m at the final shaft. The driven shaft rotates at constant speed of the ratio arranged to obtain reciprocating motion in vertical shafts. The cam mounts on periphery of the vertical shafts (beaters) contacts with rocker arms attached on the follower shaft (horizontal shaft) to generatethe reciprocating move. Thereby it lifts the beaters equal height to the length of the rocker arm alternatively and falls down by self-weight. Thus, this process repeats until the fine powder of millet (grains).

DESIGN ANALYSIS

A. Determination of force exerted by each beater

It is essential to determine the force and pressure exerted by the each beater. The pounding efficient depends on the density of materials used and the height lifted during reciprocating action of the beaters.

Force of one beater

$F = m \times g$

m = density × volume

Volume of beater = $\pi \times r^2 \times h$

$= \pi \times 2.5^2 \times 120$

$= 2355 cm^3$.

Mass of the beater = density × volume

$= 7.85 \times 2355$

$= 18486.75 g$.

m = mass
g = acceleration due to gravity [$9.81 m/s^2$]
h = height to which hammer is being lifted.
r= radius of beater
[density = $7.85 g/cm^3$]

Force of beater= 181.48 N
Diameter of trough= 200mm

=18.50 kg. (For each beater)

Therefore, Force = m × g

= 18.50kg × 9.81

=181.48N

B. Pressure exerted by each beater on the base trough

$$Pressure = \frac{Force}{Area}$$

$$P = \frac{181.48}{\pi * 0.1^2}$$

P= 5779.62N/m^2

C. Determine of speed at driven pulley

The size of driven pulley is much larger than the driver pulley to decrease the speed ratio of shaft. Therefore, the final speed will be less than the input speed. Final speed is calculate through following equation.

D_1 = Diameter of driving pulley = 50mm

D_2= Diameter of driven pulley = 500mm

N_1 = rpm of driving pulley =500rpm (motor)

N_2 = rpm of driven pulley =?

$$\frac{500}{N2} = \frac{(500)}{50}$$

N_2= 50 × 500/500

N_2= 50 r.p.m.

As the rocker arm mounted on the follower shaft, it makes equal revolutions to the shaft. Therefore, the beater will reciprocateto equal to the revolution made by a rocker arm in a minute.

Stroke of a beater per min = rpm of driven shaft

= 50 strokes/min

Total strokes of two beaters in a minute = 2 * rpm of driven shaft

= 100 strokes/ min

D. Pounding capacity

The pounding capacity of the machine can be determined by the following equation,

$V_m = V_t - V_b$ ..... (i)

V_m = Maximum pounding capacity

V_t = Volume of trough

V_b = Volume occupied by beater

R = radius of larger diameter (cm)
r = radius of smaller diameter (cm)
h = height of the cone (cm)

The volume of trough equation is given by

$$V_t = \frac{\pi}{3} h(R^2 + r^2 + Rr)$$

$$V_t = \frac{\pi}{3} * 30(15^2 + 10^2 + 15 * 10)$$

V_t = 14,915 cm^3

r = radius of beater (cm)
h = height of the beater occupied inside the trough (cm)

The volume of beater equation is given by,

$$V_b = \pi * r^2 * h$$

$$V_b = \pi * 5^2 * 30$$

V_b = 2,355 cm^3

Substituting the value of V_t and V_b in equation (i)

V_m = 14,915– 2,355
V_m = 12560 cm^3
Therefore, the maximum volume of millet can be pounded is 12,560 cm^3.

CONCLUSION

The design of pounding machine has been inspired by the problem faced during pounding of agricultural products for farmers in Asian countries. This designwill benefits the farmers in employing efficient and less time-consuming process at the basic levels. Although there are mechanized machines in the market, but farmers are not able to employ it due to its cost. The approached design is simple in construction and will cost less compare to the existing machine so that every individual household can effort to buy.

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