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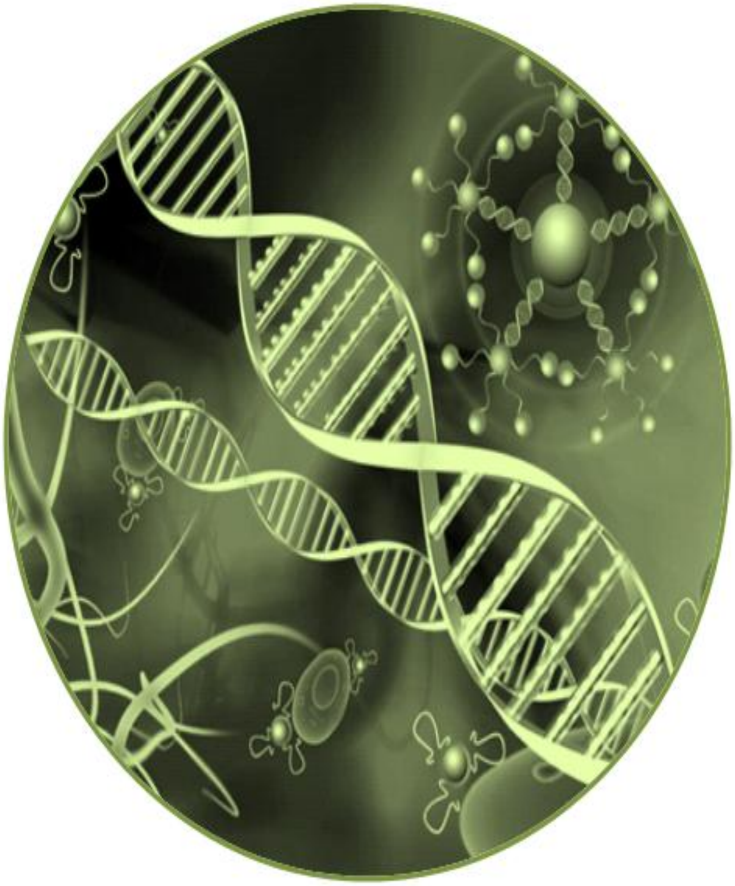

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DESIGN AND FABRICATION OF A SOLAR POWERED GRAIN GRINDING MACHINE FOR HIGHER PRODUCTIVITY

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ABSTRACT

This project describes the design and construction of a solar powered grain grinding machine. Grains are hard seeds of food plants such as maize, rice, beans, millet etc. the materials used for the construction include mild steel which is locally available. The sole aim of this project work is to control environmental pollution which arises through the use of internal combustion engines. The components used in the fabrication of this machine include; solar panel, electric motor, charge controller, grinding chamber, cell etc. The required power to operate the machine was calculated to be 1.72 kw and the volume of the hopper is 0.001904 m3. The solar panel has power of 130W, and current of 7.42Amps. Testing was carried out using dry maize, the grinding was efficient at first grinding i.e has a good friability. The machine does not require much repetition of grinding a particular product to achieve a better friability. The machine on test has efficiency of 81.25%. This design and fabrication work was carried out taking into cognizance relevant information such as power required and cost effectiveness for higher agricultural productivity.

Key words: Design, grains, fabrication, solar power, productivity.

1. INTRODUCTION

Milling transforms grains into flour for food preparation. The main crops that are milled are maize, rice, sorghum and millet, using hammer or plate mills. A hammer mill crushes aggregate material into smaller pieces with hammers (beaters) made from hardened alloy steel which are rectangular for efficient grinding. Hammer mills are also used to pulverise by-products of coconuts (copra), palm kernels & other oil seeds (press cake), Joseph (2004). Wheat is milled with roller mills but these are too expensive for small-scale operations. Although demand may be highest during the harvest season, grain milling is required throughout the year as many households keep a stock of grain. In the preparation of the cereals for further processing, the chaff has to be separated from grain, either manually with a winnowing tray or mechanically by a powered shaker or grinder. Mechanical power is also available for dehusking rice or shelling maize as an alternative to manual work with rice hullers or huskers and maize shellers. The same applies to other cereals and crops for which special machinery has been or is being developed. Bran as a by-product of dehulling cereals is a source of income if sold as poultry feed and other animal feed. According to Alexander (2010), most operations utilize energy derived from mechanical power, with many alternatives for technologies powered by human, animal, water, sun or a stationary engine. Mechanized grain grinding operations are far more efficient and far less labour intensive than manual methods, using wind/micro-hydro, solar and hybrid power systems (wind/hydro/diesel) for energy intensive processing activities. Grain grinders can be powered directly by transforming energy from sources such as wind or water or sun or by electricity generated from a combination of fossil fuel-fired generators with wind or hydro power, Wikipedia (2015). Without electricity, grain mills are often driven by diesel motors, for example, in the so-called multi-functional platforms.

Statement of the problem

The problem observed that propelled to the design was the intermittent supply of electricity from the national grid and high environmental pollution caused as a result of exhaust emissions from internal combustion engine which were used to drive the existing grain grinding machine

Objective of the project

The main objective of this project is to design a solar powered grain grinding machine. Other specific objectives are; To introduce improved design of a grain grinder. To produce a more cost effective machine for domestic use.

Materials and Methods

Materials

In designing this machine, we considered some factors that are capable of influencing its cost, reliability and complexity.These factors include; ductility, tensile strength, resistance to heat and corrosion, availability of materials, machinability and weldability. The different components of the machine are;

- Hopper
- Conveyor shafts
- Electric motor
- Grinding disc
- Transmission belt
- Pulley
- Grinding chamber
- Base frame and support unit
- Bearings
- Charge controller
- Solar panel
- Cell or batteries
- Electric cable

Construction of prototype

The manufacture of solar powered grinding machine was started by first selecting the materials from the different local markets in the country, following the design data and specifications, Alucho (2010). The materials procured were cut to the required size using manual hacksaw, power hacksaw and filing machines in the workshop. A tape rule was used to measure and determine the length, width and height of the various components of the machine cut and prepared. A scriber, compass, vernier caliper, micrometer screw gauge, and dial indicator were used for the different measurement and determination of dimension. Hand grinding and cutting, electrically operated cutting and gloating machine were used to cut some of the materials like the angle iron and the galvanized sheet metal for the casing and hopper.

Results and discussion

Testing of the prototype

The machine was tested with a power supply which was converted to mechanical energy through the help of 2.1 kw D.C electric motor. The machine was then set in motion and the maize was poured into the hopper and was finely grinded in the chamber and the fine particles were collected through the outlet.

Discussion

From the result of the test, the crushing efficiency of the machine was found to be 81.25% for dry maize. It is clear from the crushing capacity and efficiency above that the performance of the machine is satisfactory. The loss obtained was due to the sticking of the powdery materials to the wall of the crushing grinder, some strains that did not pass though the conveyor shaft and from small openings of the grinding chamber.

Conclusion

The design and fabrication of a solar powered grain grinding machine has been found to be effective and efficient. It has a greater capacity and is very safe to operate, comparatively. Therefore, it can be used by both rural and urban inhabitants.

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Table 1. Result of design calculations and specifications

S/N	PARAMETERS	VALUES
1	Resistance of the regulator	200Ω
2	Battery discharging time	54mins
3	Battery charging time	13.125Hrs
4	Volume of hopper	0.001904m^3
5	Mass of the hopper	14.968Kg
6	Speed of the motor	1400rpm
7	Total length of belt of pulley system	1.23m
8	Speed of pulley	1330.55rpm
9	Velocity of shaft pulley	4.765m/s
10	Velocity of motor shaft pulley	4.765m/s
11	Tension on the tight side of pulley system	650.35N
12	Tension on the slack side of pulley system	230.619N

13	Belt width	9.67mm
14	Power transmitted by the driven shaft	1.72kw
15	Frictional torque acting on the disc	59.68N/m
16	Life span of the ball bearing	4.28×10^6revs
17	Capacity of the machine	190.48Kg/s

Table 2: Result of test using dry maize

Trials	**Mass of maize before grinding (kg)**	**Mass of maize after grinding (kg)**	**Time taken (sec)**
1	0.4	0.34	15
2	0.4	0.28	14
3	0.4	0.36	13
4	0.4	0.32	16
Average	0.4	0.325	14.5

Average mass of the maize before grinding = 0.4 kg

Average mass of the maize after grinding = 0.325 kg

Average time taken = 14.5 sec

According to Khurmi eta'l (2005),

Crushing efficiency = $\frac{average\ mass\ of\ output\ material}{average\ mass\ of\ input\ material}$ x 100

$= \frac{0.325}{0.4} \times 100 \quad = \quad 81.25\%$

Losses = $\frac{M_b - M_a}{M_b}$

Where M_b = Mass of maize before grinding

M_a = Mass of maize after grinding

∴Losses = $\frac{0.4 - 0.325}{0.4}$ = 0.1875

Fig. 1. Fabricated grain grinding machine.