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IMPROVED DESIGN OF AUTOMATED PLANTAIN SLICING MACHINE, USING LOCAL INPUTS. BY

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Abstract: -

We designed and fabricated an automated plantain slicing machine out of the need to assist industrial plantain Chips Companies to improve the efficiency of their production process. This design consists of 2 blades as against one in the previous models. The machine was tested with some plantain fingers, to compare its performance with the existing models, this machine was used to slice 342 times as against 50 times in the existing model. All components used to produce this machine were sourced locally thereby reducing cost of production. It is believed that the automated slicing machine will enhance the productivity of the sub-sector

Keywords: - *Design, automated slicing, fabrication, efficiency, productivity*

INTRODUCTION

Plantain is a popular food in Nigeria and many other countries in the world. Although, many western consumer see it as a mere super market bought. Millions of people in the world's poorer regions see plantain as a starchy staple of major important especially in Africa (Ajayi, 2013) s.

The consumption of plantain is done in different conditions either peeled or unpeeled before it is being boiled, roasted or fried as sliced or unsliced plantain. Also, it can be processed via slicing, drying and gridding for the production of plantain flour which can also be consumed when baked. Investigations showed that plantain slices have high consumption rate (fried) by travelers, office workers, young lovers, school children, pupils and families as part of breakfast.

Through the investigation, it was discovered that the earliest manual method of producing plantain chips resulted to the following disadvantage: Time consumption, Laborious in nature, Low productivity, non-uniformity in thickness and length, very expensive cost of the products.

Based on the investigation result and findings, an imperative consideration was made for the design and manufacture of an automated plantain slicing machine that will at least alleviate the disadvantages that are associated with the manually operated machine.

Problem Statement

During the past four decades, food production has failed to keep with population growth in many African countries. Severe food insecurities continue, food import bills have been soaring and agricultural export earnings have been declining. To reverse these trends, we saw the need to produce food faster to meet up with population growth. One commodity that holds great potential in industrial production is plantain.

We come up with a machine that would slice plantain faster, thereby saving time which is a very serious factor in commercial production. This machine will also avoid injuries entirely and guarantee safety in slicing of plantain for large scale production. .

Materials and Method

The design analysis of the machine involves critical analysis of the stresses in the machine, according to Ibhadode (2012), with the individual components weight standing out as a factor, also considering the bending moments with the geometric properties and weight of the individual components being its centre of emphasis. This analysis was done in order to establish definite parameters for the machine structure system or process to be designed, considering limitation and constraint posed by material requirements, economic consideration, aesthetic, features and other engineering considerations.

The following design considerations of the portable plantain slicing machine were made.

i. The plantain cutting machine should be able to save time, energy and be efficient in productivity.
ii. The machine should be able to provide adequate safety and reduce drudgery in slicing of food items and should also be simple in operation and ease to maintain.
iii. In the material selection for fabrication, adequate care and study on the materials should be made to avoid using materials that will or may contaminate food items then leading to food poisoning.
iv. All parts of the machine and product contains surfaces must be completely free from crevices which may harbor bacteria and virus
v. The machine should be able to be operated or used by anyone without pre-training or study of the operating principles.

Material selection is vital and important factor in the design and fabrication of machines both for domestic and industrial applications. This is because the strength and durability of the machine and its ability to withstand failure lies on the physical and mechanical properties of the materials used. Therefore, a sound knowledge of the physical and mechanical properties of the selected materials for the fabrication of the machine were known.

Stainless Steel: This material was used in the design and fabrication for the cutting blades, the food hopper or food tray and the top cover where food items will be in constant contact.

Mild Steel: This was used in the fabrication of the stand or mainframe of the machine because of its physical and characteristic properties as a construction engineering material.

Perspex: Perspex material was also used in combination with the stainless materials in the design.All these materials are locally available.

Design Consideration

In the design of the plantain slicing machine, the following areas of engineering design consideration were thoughtfully considered, the areas are as follows:

i. Load acting on the machine members, example, the shaft, the cutting blades and the mainframe (body) etc.
ii. Determination of maximum cutting angle of the machine
iii. Determination of the effective capacity of the slicing machine.

Alternative Current (A.C) Motor

An electric motor is a machine which when supplied with a direct current, can be sued to some mechanical work. Direct cement motors are widely and specifically used in engineering applications where speed control are enquired The power rating of the D.C motor used is 25 w, and with a speed of 1200 rpm. Hence to obtain the torque acting upon the shaft of the motor we used the equation;

$$P = \frac{2\pi Nt}{60}$$

Where p= power of motor = 25W
N= motor speed = 1200 rpm
T= torque (Nm)
Therefore, torque, $T = \frac{6}{2\pi N}$
:. Torque, T = 0.199 NM

The Speed Control Unit (Circuit)

The speed control unit or circuit is designed and built to control and regulate the speed of the motor which is very vital in determining the cutting force and speed of the blades since different cutting speeds are required to cut different agricultural materials
The force required to cut given material is given as F.
$F = mw^2r$
Where
M = mass of the cutting blades = 0.4kg
W= angular speed of the motor shaft = $\frac{2\pi N}{60}$
R= length of cutting blade
At N= 1200rpm
The angular speed, $w = \frac{2\pi N}{60}$

$$W = \frac{2\pi \times 1200}{60} = 125.6 \text{ red/sec.}$$

But r = length of the cutting blade which is equal to 120mm = 0.012m

Therefore force required to cut or slice a given agricultural material, F is
$F = Mw^2r$
$= 0.4 \times (125.6)^2 \times 0.012 = 75.7$
F= 75.7N

This is the force required by one cutting blade. Since 14 blades act on the material along the length of the cutting chamber at a times, the force required to cut the material will be given is

$$F = 75.7 \times 14 = 1059.8N$$

Results and Discussion

The machine is produced to slice plantain at a particular setting. The speed and productivity of the machine is dependent on the voltage of electricity used to power the electric motor but the machine was tested at its lowest possible electric rating and it sliced 4 times in one revolution in approximately 1.2 seconds that is approximately 200 slices in minutes.
It was also tested at its highest possible rating and it sliced 4 times in one revolution in just under a second, approximately 0.7 seconds, equivalent to 342 slices in one minutes.

Table 4.1 Table of values for chart in Test run

Machine	Low Speed	High Speed	Older machine
No of Slices in one Minute	200	342	50

Conclusion

The portable plantain slicing machines was designed to produce fine and neat slices of the plantain.
Moreover, the machine was found to consume less energy as compared to other machines hence reducing cost and maximizing profit. It will also prove suitable in many different areas, such as, food processing industries.

References

[1].Case J. Chilvera A. U (2013), "Structure of Materials," 2nd edition, Elbs.
[2].Farag M.M (2011) Selection of Materials for Engineering Design; Prentice Hall, New York.
[3].Ibhadode A. O., (2012), "introduction to Manufacturing technology", 2nd edition, Ambik Press.
[4].Joseph Ajayi, (2013), "Agricultural sciences for West Africa" 2nd edition

[5].James Carnvill, (2011), “mechanical Engineering data Handbook”, Stanley
[6].Thornes Publishers Limited. Uk
[7].Khurni R.S. and Gupta J.K (2004); “A Textbook of; Machine Design”, Eurasis
[8].Publishing House (PVT) Ltd Ram Nagar, New Delhi
[9].Nwanekezie C. And Ukagu J. C (2010), “Nigeria Food Journal”, volume 17, pp 55.