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Construction and Performance Evaluation of a Potato (*Solanum Tuberosum*) Slicing Machine

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***Abstract*—Manual slicing of potato in production of chips is crude and manual; the process is very tasking, laborious and consumes very high energy. Thus, the objective of this study was to construct and evaluate the performance of a potato slicing machine. Materials used for the construction of the slicing machine were sourced locally and the selection of materials was based on cost adaptation, portability, durability and ergonomics adequacy. Essential features of the slicing machine include: frame, slicing disc, hopper, table, Outlet, Electric Motor Seat. The performance of the machine was evaluated five times; parameters determined include machine capacity and functional efficiency and slicing efficiency. The machine capacity ranged from 35.5 – 47 kg/hr with an average value of 41.2 ± 1.2 while the functional efficiency ranged from 39.9 – 83.5% with an average value of 63.8% ± 14.7. The cost of maintenance of the machine is low and it is simple to operate. The capacity of the machine will help to conserve timeliness of operation, improve productivity and reduce drudgery which is very significant in the manual production of potato chips.**

Keywords—potato slicing machine; machine capacity; functional efficiency.

I. INTRODUCTION

Potato (*Solanum tuberosum*) is the world's fourth largest food crop, following rice, wheat and maize. Agriculturalists found potatoes easier to grow and cultivate than other staple crops, such as wheat and oats. Most importantly, it became known that potatoes contained most of the vitamins needed for sustenance, and they could be provided to nearly 10 people for each acre of land cultivated. The Irish working class lived largely on potatoes and when the bright reached Ireland, their main staple food disappeared [1]. Potato has high nutritional value and potential to conduce high income. Potato is said to complete food as it contain carbohydrate, protein, vitamin B, vitamin c and Minerals like potassium, calcium and iron required for body growth, it is also one of the major vegetable crop of the world, richest source of starch and calorific value. It produces more food per unit area than any cereal crop within short period in Indian; various products prepared from potato are chip, finger chips, cubes, flour etc [2], [3]. The lack of established marketing channels, inadequate institutional support and infrastructure and restructure trade policies are impediments to commercialization of the sector. National and International stake holders need to place potato higher on the development agenda [4]. Potato production in developed countries, especially in Europe and the common wealth of independent states has declined on average by one percent per annum over the past 20 years. Nigeria is the third largest producer of sweet potatoes in the world however, potato is still being processed traditionally which is tedious, time consuming, energy sapping and generally low in productivity. [5], [6], [7], [8], [9] have designed slicing machines for yam, Plantain and carrot, okra, yam, plantain respectively. A major processing operation of potato is slicing in order to produce chips; this process involves cutting the tubers into smaller pieces, this process is crude and manual in some developing countries like Nigeria which is very tasking, laborious and consumes very high energy. [10] designed a potato slicing machine but there is need for an improvement thus, the objective of this study was to construct and evaluate the performance of a potato slicing machine.

II. MATERIALS AND METHODS

The design of potato slicing machine require the basic information such as mechanical properties of potato, capacity of the machine, efficiency of the machine, main specification of the material etc.

A. Materials

The materials used for the construction of potato slicing machine were sourced locally at various market in Ibadan, Oyo State, Nigeria. The machine designed was based on materials selection, cost adaptation for both commercial and subsistence use. Other factors include portability, durability and ease of utilization of the machine.

B. Constructional Features

The essential features on the potato slicing machine include: frame, Slicing Disc, hopper, table, Outlet, Electric Motor Seat (as presented in Figure 1).

Potato Slicer		
Part no	Part name	Quantity
1	Cover	1
2	Slicing disc	1
3	Inlet	1
4	Hopper	1
5	Shaft	1
6	Pulley	1
7	Engine seat	1
8	The Table	1
9	Cover frame	1
10	Washer	6
11	Outlet	1

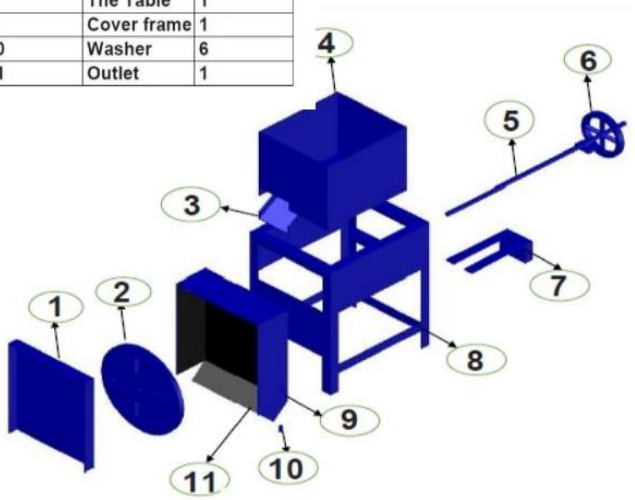

Figure 1: Component Part Drawing of the Potato Slicing Machine

C. The Frame

This was made of strong angle Iron which was accurately measured and cut into required length and size. They were welded together using butt and fillet weld. The frame was rigidly supported by some braces which enhance the stability of the machine. Besides the left hand side of the frame was welded an engine seat which was also made up to angle frame provides adequate support for entire loads distributed on or iron within the slicing machine. To ensure this 45mm x 45mm angle iron was used.

D. The Slicing Disc

This is the circular cutting mechanism which obviously represents the heart of the machine. Slicing Disc is made of 3mm stainless plate of about 400mm diameter upon which the rectangular blades were arranged for cutting and slicing operation. This was mounted vertically and perpendicularly to the hopper part of the machine.

E. The hopper

This is located at the rear part of the machine inclined at a particular angle of repose. It holds potato and ensures its continuous feeding towards the slicing blades of the vertically positioned disc, Plate 1 and 2 shows plan view of the hopper and the machine respectively.

F. The Table

This made of stainless materials and it is the component part which holds the bulk of materials (potatoes) in place before introducing them through the hopper. It comprises of box like structure to prevent the escape or splashing of potato tuber where there is excessive vibration of the machine.

G. The Outlet

This is an exit point where the sliced potatoes were finally collected. This is made up of an extended chute converged to aid easy collection of materials. It is located below the slicing disc cover at a convenient angle of repose for materials to flow without obstruction.

H. Electric Motor (Prime Mover)

This is the major power transmission element for potato slicing machine, through internal combustion engine like petrol engine can also be used to perform the same purpose. Five (5) horse power electric motor or petrol engine is suitable to power the machine. Electric Motor is required to supply energy for driving the machine to achieve slicing operation.
Factor taken into consideration before using electric motor are:

i. Horse power requirement of machine to be operated
ii. Speed of the motor
iii. The torque or inertial required

I. Performance evaluation of potato slicing machine

The following factors were considered in evaluating the performance of the machine as reported by [11].

i. Machine capacity (kg/hr): this was obtained as the ratio of the mass of chips produced to the time of slicing (Equation 1). The mass of chips produced per operation was measured using digital weighing balance. The time taken to slice each potato was taken using stopwatch

$$M_C = \frac{Wc}{Tt} \quad (1)$$

Where: Wc is the mass of chip produced (g), Tt is the Time taken to produce the chips.

ii. Machine functional efficiency (%): The expected thickness of chips was calculated from the average of five different thickness of chips produced from one potato with the aid of digital venier caliper. The length of potato was measured using tape rule and the total number of chips was known by counting the number of chips produced from one potato. Machine functional efficiency was calculated by the ratio of number of chips produced to the expected total number of chips per operation (Equations 2 and 3).

$$\sum f = \frac{Nc}{Ne} \quad (2)$$

$$Ne = \frac{L}{X} \quad (3)$$

Where: Nc is the Number of chips produced, Ne is the Expected total number of chips per operation, L is the Length of peeled potato, X is the Expected thickness of chips.

III. Results and Discussion

A potato slicing machine was designed, constructed and evaluated using standard procedures, the results obtained for machine capacity and functional efficiency is presented in Tables 1 and 2 respectively.

Table 1: Machine Capacity

Replicates	Initial Mass (g)	Mass of Chips Produced (g) Wc	Time Taken (sec) Tt	$\frac{Wc}{Tt}$ (kg/hr)
1	237	210	20.00	37.8
2	247	217	22.00	35.5
3	235	212	18.00	42.4
4	245	238	19.00	45.1
5	218	209	16.00	47
Average	236.4	217.2	19.00	41.2
S.D	10.26	11.12	2.00	1.20

Table 2: Machine Functional Efficiency

Replicate	L (mm)	X (mm)	$Ne\ \frac{L}{X}$	Nc (No of Chips)	$\sum f = \frac{Nc}{Ne}$
1	127	7.50	16.93	10	59.07
2	143	7.46	19.17	12	62.60
3	137	8.08	15.57	13	83.49
4	133	5.30	25.09	10	39.86
5	127	6.70	18.96	14	73.84
Average	135	7.15	19.14	11.80	63.77
S.D	5.83	1.14	3.25	1.60	14.73

A. Discussion

Machine testing and evaluation was carried out in Federal College of Agriculture workshop, Moor Plantation, Ibadan, Nigeria. The machine capacity ranged from 35.5 – 47 kg/hr with an average value of 41.2 $\pm$ 1.2 while the functional efficiency ranged from 39.9 – 83.5% with an average value of 63.8% $\pm$ 14.7. It was observed that the usage of the machine saves timeliness of operation, an average man manually potato produces an average of 2.083 kg/hr from the authors field assessment carried out also, the cost of maintenance of the machine is low and the machine is simple to operate. The machine will improve productivity and reduce drudgery unlike manual production of potato chips. The results obtained are in similar trend with literatures: [5], [6], [7], [8], [9] for yam, Plantain and carrot, okra, yam, plantain respectively.

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References

[1] Khurana, P. (2006). Hand book of potato production improvement and post harvest management.haworth pess isbn 978-1-5602272-9. pp 481-483.

[2] Hawkes, J.G. (1990): The potato: Evolution, Biodiversity and Genetic Resources, *Smith Sonian Institution Press*, Washington, D.C Pp. 34-56.

[3] Hawkes, J.G. (1993): Modern Taxonomic Work on *Solanum* Species of Mexico and Adjacent Countries. *American Potato Journal,* 43: 81-103. Pp.51-56

[4] Virginia, A. and Elena, M. (2001): "Classification and measurement of nutritionally important starch fractions" *International Journal of Developmental Biology,* (45): 537-538.

[5] Ukatu, A.C. and Aboaba, F.O. (1996): A Machine for Slicing Yam Tuber. *Journal of Agricultural Engineering and Technology*, 4: 58-64.

[6] Obeng, G.I. and Odekunle, O. (2004): Designated Fabrication and Testing of Mechanization Plantain and Carrot Slicer. *Technology Consultancy Centers Kwame Nkrumah University Science for West African Schools, Ghana,* 24(2): 26-133.

[7] Owolarafe, O.K., Muritala, O.A. and Ogunsina, B.S. (2007): Development of an Okra Slicing Device. *J. Food Science Technology* 01, 44(4): 426-429.

[8] Neidhardt O. (2008): Design and Fabrication of a Yam Tuber Peeling and Slicing Machine for a Poundo-Yam Process Plant. *Department of Mechanical Engineering.* Federal University Akure, Ondo State Nigeria, pp. 56-78.

[9] Adeyanju, J. (2014). A machine for slicing plantain. *Journal of Agricultural Engineering and Technology*, pp. 11-14

[10] Aminu, O.Y. (2007): Development of Potato Slicing Machine. Department of Mechanical Engineering Faculty of Technology Bayero University, Kano, Nigeria. Pp. 119-127

[11] Adewunmi, B.A. (2007): Agricultural mechanization infact for sustainable raw material sourcing in Nigeria. Chapter 8 in Nigeria agro raw material development, *Book Publication by Raw Material Research and Development Council of Nigeria,* 1: 126-141.