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FABRICATION OF POTATO SLICING MACHINE

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Abstract

*Potato (*Solanum tuberosum* L.) is one of the most important food crops in the world. In terms of production, potato ranks fourth as food crop in Nigeria after cassava, yam and cocoyam. Potato is a cheap source of nutrients, income and employment to guarantee food security. However, potato is a semi-perishable commodity. Therefore, it needs processing for both short and long term storages. Hand held slicer being used by local processor of potato chips is prone to injuring the user through cut from blade during operation, time consuming and laborious. Also, most of available machines are costly and not made locally. The research work fabricated a portable and effective slicing machine. The frame was fabricated using angle iron (3mm), the cutting disc (3mm) was made using a stainless steel connected to a shaft (25mm) supported by bearings. The inlet chutes were made of stainless pipe (3mm) and discharge chute (1.2mm) made of stainless sheet. The machine is powered by a 1hp electric motor. The cutting disc carries three blades at 120°. The slicing is carried out by impact and shear action of the cutting blades. Three slices are produced by one revolution of the cutting disc. The machine has the slicing capacity of 217.3kg/hr, throughput capacity of 346kg/hr and efficiency of 63.4%. This efficiency can be improved upon. The machine is portable (430 × 420 × 780mm) and easy to operate by one person. It is not prone to injury like the hand held manual slicer.*

Key words: *Potato; Slicer; Chips; Fabrication; Size reduction*

Introduction

Potato (*Solanum tuberosum* L.) is one of the most important food crops in the world. They are of two types; sweet and Irish potato. In terms of production, potato ranks fourth as food crop in Nigeria after cassava, yam and coco yam (Okonkwo *et al*, 2009). FAO (2000) as found in Gbigbi (2011) reported that production of sweet potato in Nigeria increased from 149,000 metric tonnes in 1961 to 2,468,000 metric tonnes in 2000. Area of cultivation increased from 13,000 ha to 381,000 ha over the same period. Nigeria was ranked to be the largest producer of potato in Africa, and the second largest producer in the world after China in 2014 (FAO, 2015; Adeyonu *et al*, 2019). Potato is a cheap source of nutrients, income and employment to guarantee food security (Lutaladio and Castaldi, 2009). The storage roots of sweet potato serve as staple food and animal feed (Posas, 1989). Sweet potato is consumed boiled, baked, roasted or fried. However, potato is a semi-perishable commodity. Therefore, it needs processing for both short and long term storages. Reducing the size of food raw materials is an important operation to achieve a definite size range (Henderson and Perry, 1980). Poor qualities of potato products as well as high post-harvest loss of potato often result from the use of low grade processing machineries. Poor end potato slicer produces uneven thickness of slices due to design fault which causes uneven drying followed by fungal infestation. Usually potato farmers have no other option without selling their potatoes at farm gate prices to the middlemen to get at least minimum return before spoilage. Low return discourages farmers and production per head is greatly reduced in the following years. To overcome this problem, potato farmers can peel, blanch and dry their tubers either in lumps or in slices and store them for better profits (Ehiem and Obeta., 2011). Several slicing and chipping machines have been designed and tested by various researchers. Various types of machines are manufactured from small hand-operated batch-types to large automatic continuous operation models. Some are petrol, diesel or electric motor operated. Ukatu and Aboaba (1996) designed, constructed and evaluated a machine for slicing yam and it was reported that the machine's thickness of cut can be varied from 2 mm to 20 mm and the slicing efficiency ranged from 82 to 93% and the rate of work is 45 cuts per minute. Raji and Igbeke (1994) designed, fabricated and tested a pedal-operated chipping and slicing machine for tubers and it was

reported that the machine performed satisfactorily with production of slices of uniform thickness ranging from 1 mm to 13 mm thickness and a throughput of about 376 kg/h at an efficiency of about 83%. In Nigeria a number of researchers have worked on production of slicing machine for various crops such as okro, onion and tubers (Odigboh 1976). Latt and Thaw (2019) designed a motorized potato slicing machine that works on shearing force of a circular cutting disc with two blades and one loading chute. It was reported that the machine has efficiency and throughput capacity of 88% and 258kg/hr respectively. The blade can only cut two slices of 3mm thick in one revolution. The blade requires special machining which may not support local production. Aji *et al*, (2013) developed a cassava chipping machine which operation was based on impact of the cutting disc on the tuber and the shearing force on the grooved cutting blade on the cutting disc. It was reported that the machine has the average capacity and efficiency of 318kg/hr and 95.6% respectively. Up till now many potato chips producer still rely on hand held manual slicer that is prone to injury, laborious and time consuming. Some of the existing slicers are costly and not produced locally. Hence, this research work aimed at producing a slicer for potato that will be cheaper, portable and effective.

Materials and Method

Materials

Table 1: Materials used in the fabrication of a potato slicing machine

S/N	Part	Materials used
1	Hopper	Stainless sheet (3mm)
2	Frame	Angle iron of (3mm)
3	Casing	18 gauge plate (2mm)
4	Shaft Supports	pinion bearings of (25mm) size
5	Power transmission	Mild steel pulley
6	Transmission of torque	stainless shaft (25mm)
7	Outlet unit	Stainless sheet (1.2mm)
8	fasteners	Bolts and nuts
9	Slicing disc	Stainless steel (3mm)
10	Power source	Electric motor (1hp)

Material selection criteria

The materials for fabrication of the machine were selected based on the following:

- Availability
- Low cost
- Corrosion resistance
- Strength of the materials

Fabrication considerations

The following were put into consideration while designing the machine:

- Portability
- Ease of operation
- Uniformity in the size of the potato sliced
- Ease of maintenance

Fabrication of the machine

As shown in Plate 1, the frame was first fabricated which served as the support for other parts of the machine. The frame was made using angle iron and mild steel plate to form a box. A shaft of 25mm diameter and 610mm long is mounted vertically, both ends of the shaft were supported by a deep groove ball bearing. The downside was connected to the pulley which rotates the shaft mechanically, while the other end fastened to the slicing unit. The cutting disc was fabricated from a stainless steel plate of thickness 3mm and 400mm diameter, held in position through a slot to a key on the shaft. The length of the cutting blade which was determined from manual slicer being commonly used by potato chip producer was 80mm. The blades were made by cutting groove on the

cutting disc. The blades were at angle 120° to each other. The depth of the groove was determined from the manual hand held slicer. The inlet chutes which were 80mm, 60mm, and 40mm diameter based on different sizes that can be sliced by manual slicer was made of stainless steel of 2mm thickness which serves as receptacle through which potato is admitted into the cutting chamber and an outlet chute which is made of stainless steel of 1.5mm thickness is welded to the frame at both sides which enables the discharge of the sliced potato. The electric motor sit was made of an angle iron upon which the electric motor was fastened to power the machine.

Testing of the machine

The fabricated machine was tested to evaluate its performance on the basis of capacity and efficiency as shown in Plate 2. The machine operation is based on impact shear force. The potato tuber is fed vertically through the inlet chute underneath which the cutting disc rotates about the horizontal plane. The cutting blade on the disc cut the tuber through the impact shear action of the blade. The cut slice falls by gravity through the groove under the blade and received by a tray under the cutting disc and slide down on the discharge chute. The slices are then collected in a container. Three slices are cut by one revolution of the cutting disc. The capacity of the machine was determined by feeding 3 and 5kg tubers into the machine respectively to slice it and the time taken were recorded. The slices produced was weighed in order to determine the capacity vis-a-vis to determine the efficiency of the machine. The weight of the tubers and that of the slices produced were compared in order to determine the efficiency of the machine.

The efficiency and the capacity of the machine were determined as follows

$$\text{Efficiency} = \frac{\text{Quantity of sliced potato}}{\text{Quantity of potato}} \times 100\% \dots \dots \dots 1$$

$$\text{Through put Capacity} = \frac{\text{Quantity of potato} \times 3600}{\text{slicing time}} \left(\frac{\text{kg}}{\text{hr}} \right) \dots \dots \dots 2$$

$$\text{Slicing Capacity} = \frac{\text{Quantity of sliced potato} \times 3600}{\text{slicing time}} \left(\frac{\text{kg}}{\text{hr}} \right) \dots \dots \dots 3$$

Results and Discussion

Fabricated potato slicer

Plate 3 showed the fabricated machine. The machine is very portable (430 × 420 × 780mm) and easy to operate by one person. It is not prone to injury unlike the hand held manual slicer. The maximum and minimum efficiency of the machine from the Table 2 are 66.7% and 60% respectively, also the minimum and maximum throughput capacity of the machine are 292kg/hr and 400kg/hr respectively. The average efficiency and throughput capacity are 63.4% and 346kg/hr respectively. This a little higher than that of Aji *et al* (2013) and Latt and Thaw (2019) with capacity of 318 and 258kg/h respectively. The minimum and maximum slicing capacity of the machine are 192kg/hr and 240kg/hr and average slicing capacity is 217.3kg/hr. Although, the efficiency is lower, this could be attributed to the accuracy of the cutting angle as the blades were not specially machined. The fabricated machine has a reasonable efficiency in terms of slicing.

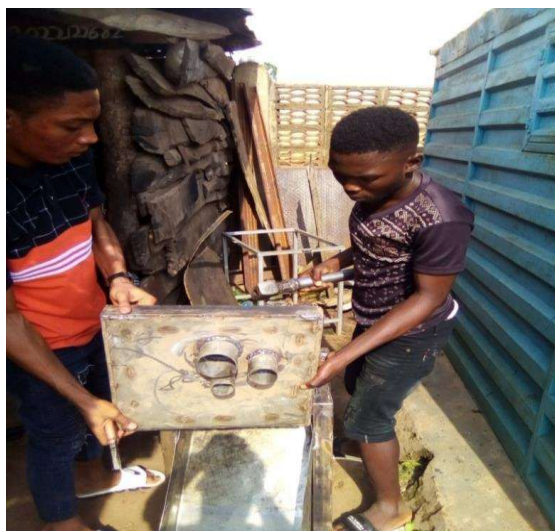


Plate 1: Potato slicer under fabrication



Plate 2: Potato slicer undergoing testing

Table 2: Throughput capacity, slicing capacity and efficiency of tested machine.

S/N	Quantity of Potato (Kg)	Slicing Time (s)	Quantity of sliced potato (Kg)	Efficiency (%)	Throughput capacity (Kg/hr)	Slicing capacity (Kg/hr)
1	3	37	2	66.7	292	194.59
2	5	45	3	60.0	400	240.00

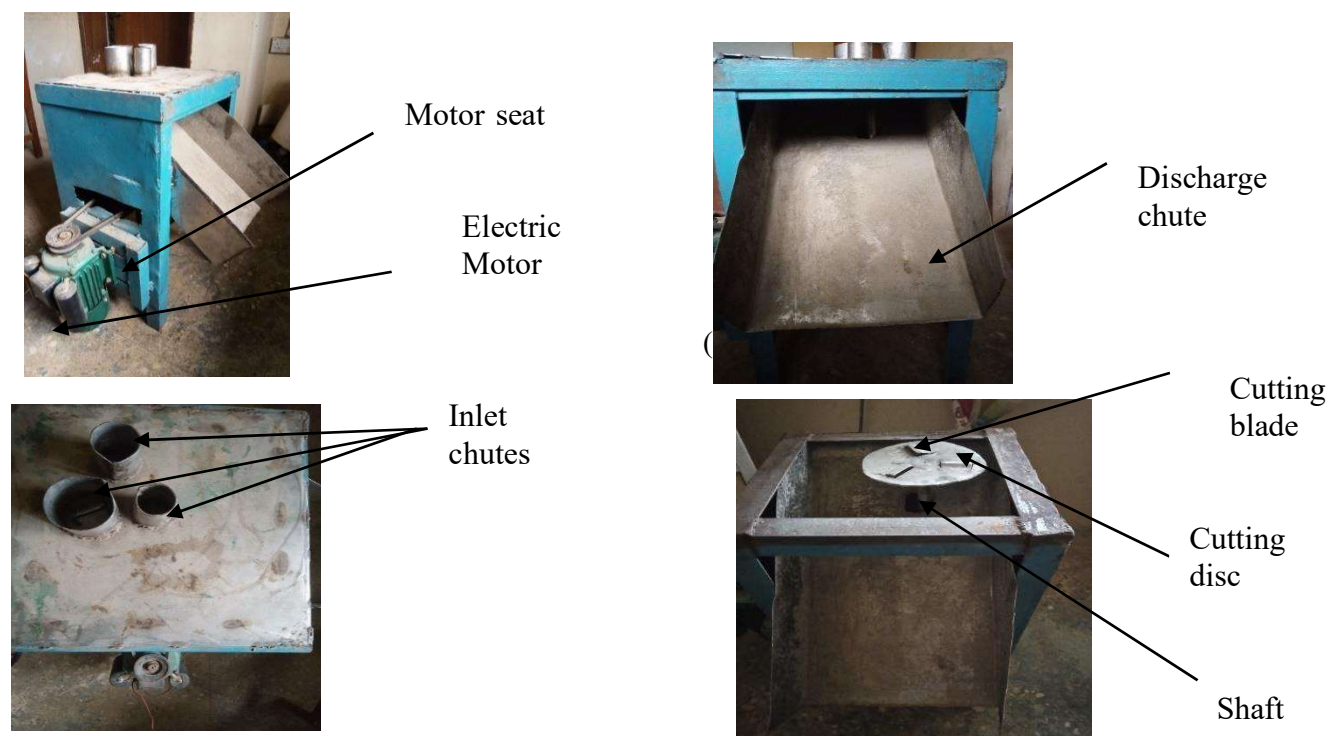


Plate 3: Different views of the potato slicing machine

Conclusion

The potato slicing machine was fabricated and tested with fresh tubers of potato. The machine was able to slice at an average rate of 217.3kg/hr with an average efficiency of 63.4% respectively. It is obvious that the fabricated machine has a reasonable efficiency and capacity in terms of slicing of potato and a good economic production capacity.

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