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PERFORMANCE EVALUATION OF NCAM PLANTAIN SLICING MACHINE

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ABSTRACT
Slicing of plantain fingers into chips for domestic and commercial purposes is a processing technique, which needs to be adequately done to reduce wastage and post-harvest losses of mature plantain. This led to the fabrication of NCAM plantain slicing machine which is portable, affordable and reduce human fatigue associated with non-mechanized way of slicing plantain. This paper presents the performance evaluation of an affordable and highly efficient plantain slicing machine, the efficiency of the slicer in slicing unripe plantain was 63.03% while that of ripe was found to be 47.42%. The machine takes 6-7 seconds to slice a finger of plantain into chips of 3-4mm in thickness and an average slicing capacity of 848.9kg/hr and 1,319 kg/hr for unripe and ripe plantain respectively. The added advantage of hygiene is also present and economic benefit for local plantain processors in the use of the machine.

KEYWORDS: Plantain, Slicing, Efficiency and Performance Evaluation.

1. INTRODUCTION

Plantain is a popular staple food in Africa and in many other countries of the world. Unripe plantain is also considered a major source of iron (Kachara et al 1995). Plantain is taken in various forms such as fried plantain, boiled plantain roasted plantain and plantain chips. It can also be processed into plantain flour by slicing, drying and grinding. Plantain flour can be reconstituted in boiled water to form dough which is normally taken with vegetable soup in the South-West part of Nigeria. The high demands for plantain slices in the society calls for an improved method of processing. The traditional way of processing is too cumbersome and unhygienic therefore it is necessary to improve the method of processing so as to meet the demand and for better quality product.

The kitchen knife method remains a primitive way of producing plantain slices and cannot support large quantities needed in small, medium and large scale industries. The problems associated with this method are fatigue, low speed which leads to poor output and low income generation, too many, hand injury, non uniformity of slice thickness, high production

time and energy wastage. Manually operated plantain slier is usually employed by small scale industries. The plantain is pressed and moved across the sharp blades of the machine and the major risk is that when it misses a cut, the operators get his finger cut by the exposed sharp blades. It is also time consuming

Plantain chips are prepared by frying round slices of unripe or slightly ripened plantain pulp in vegetable oil. The quality plantain chips can be obtained by frying slices of plantain of about 3mm thickness between temperature range of 160^0 C and 170^0 C (Anonymous 2005). In order to close the gap between the traditional method of slicing plantain and the costly imported plantain slicing machine, an affordable mechanized plantain slicer would be fabricated and the performance evaluation would be carried out for local plantain chips producers which can be used for commercial scale production.

The production of the genus of musa (plantains and bananas) hits over one hundred million tons (100 million tons) in year 2005 (FAO 2007). Presently, it is grown in over 130 countries of the tropical and sub-tropical countries of the world (Sharrock and Frison 1999), with India as the world leading producer of bananas. In sub-Sahara Africa, Uganda is the leading producer of plantain, followed by Nigeria, Ghana, Rwanda, Cote de ivory and Cameroon (FAO 2008). However, apart from these African countries, the production of plantains and bananas cut across the tropical region of the continent (CRFG 1997). In Nigeria, for agro-climate reasons, plantain cultivation is concentrated in the southern region of the country. This crop also serves as source of income for rural farmers and substantial foreign exchange can be earned from export.

Slicing is a cutting process for size reduction of fruits and vegetables. It involves pushing or forcing a thin, sharp knife to shear through the material intended to be sliced (Owolarafe *et al.,* 2007). This results in minimal deformation and rupture of the fruits cell wall. Presently, the traditional method of slicing plantain with a kitchen knife on a wooden plate is still very much in use, due to the fact that patented plantain slicers like "Robot–Couple" models are not readily available for immediate use of plantain chips producers. Nevertheless, as the plantain chips industry attract more investments depicted by the increase in the rate of packaged brands that are being sold on Nigerian roads, markets, stores, fast food joints and supermarkets, the need for a simple, affordable, easy to maintain slicing device cannot be overestimated.

The fabrication of portable and affordable plantain slicing machine to reduce human fatigue and time consuming associated to non mechanized way of slicing plantain with kitchen knife which is common in Nigeria and most west African countries is attempted in this work. The objective of this work was to carry out an intensive performance evaluation of NCAM fabricated plantain slicing machine for local plantain processors.

2.0 DESIGN FEATURES

The pictorial and exploded view of NCAM plantain slicing machine is shown in Figure 1. The details of the component part as follows: -

S/N	COMPONENTS
1	Hopper
2	Electric motor
3	Slicing disc
4	Frame
5	Belt
6	Pulley
7	Frame cover
8	Pillow bearing
9	Shaft
10	Chute

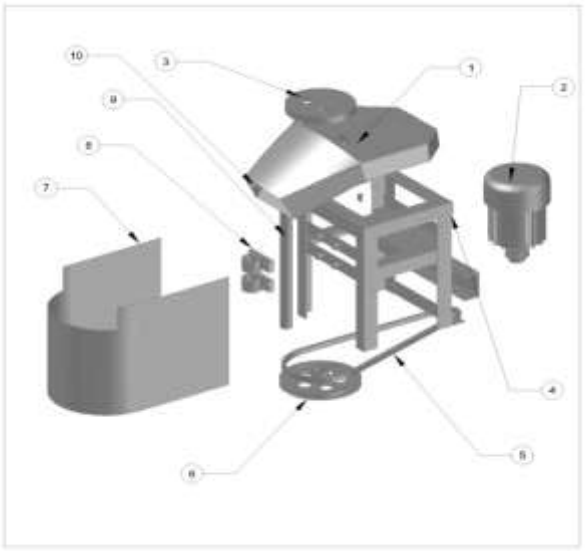

Figure 1: Exploded view

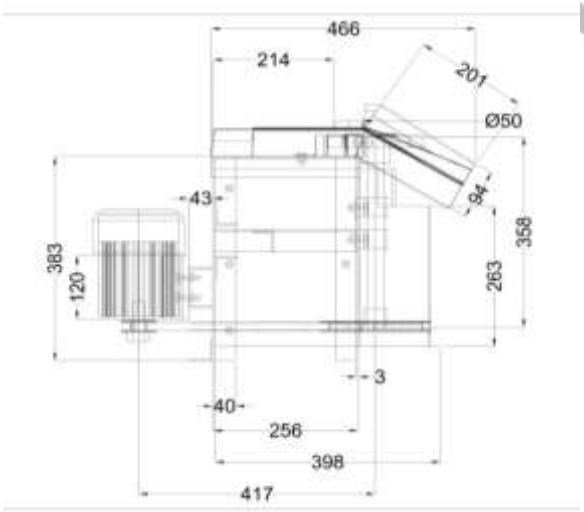

Figure 2: Orthographic Projection

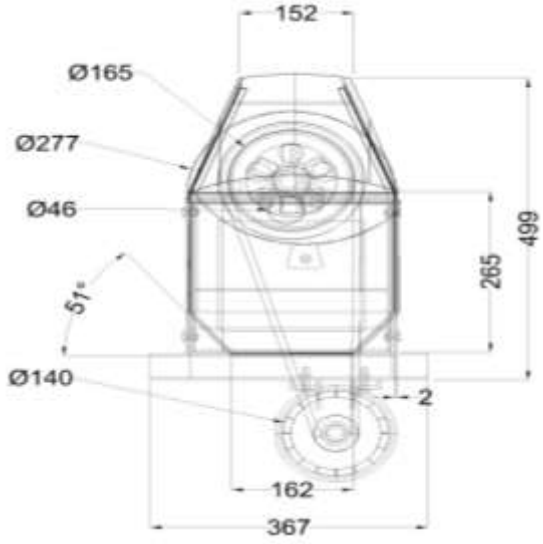

Figure 3: End View

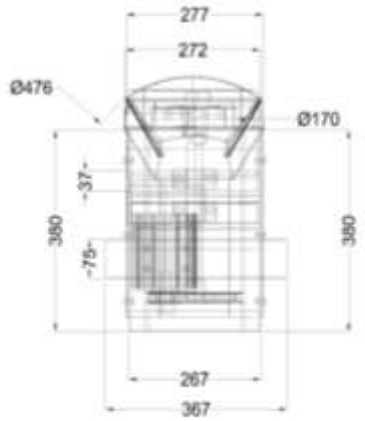

Figure. 4: Plan view

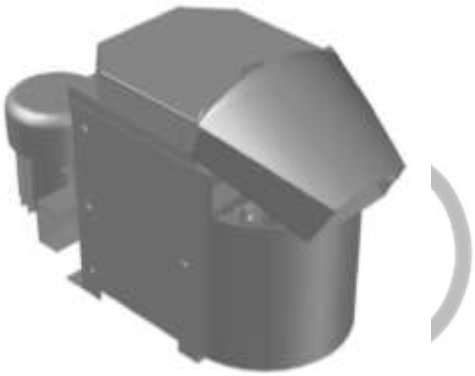

Fig. 5: Isometric view

Fig. 6: Pictorial view of the NCAM Plantain slicer**.**

3.0 MATERIALS AND METHODS

3.1 Component parts of the Machine

A plantain slicer was fabricated with the intention of easing the burden of cutting plantain and saving time. The NCAM plantain slicing machine was tested using ripe and unripe plantain fingers, to verify the efficiency of the machine in slicing these two varieties.

The investigation started with peeling of plantain using sharp kitchen knife, after peeling the length of each plantain fingers was measured using measuring tape while the diameter were measured using digital Vanier Calliper. The weight of each plantain finger was measured to ascertain it initial and final weight using digital weighing scale, the slicing machine was put ON and stopwatch concurrently to know the time that will take the machine to slice a finger of plantain, however the plantain finger was fed into the machine by the operator through the feeding chute (hopper) where the plantain was sliced and pass through the chute in to the collector or container. As the test proceeds, the final weight of sliced and unsliced plantain

chips was measured using digital weighing scale also the thickness of the sliced plantain fingers were measured using Vanier calliper to ascertain their uniformity respectively.

The machine is used to slice plantain pulp into chips. The machine consists of the following parts:

1. Hopper: The hopper is made up of stainless steel with 2 mm thickness, the height is 55 mm, and with length 270 mm while the width is 265 mm and the diameter of the hopper is 50 mm

2. Slicing disc: The Slicing disc was made from stainless steel of 2 mm thickness with 170 mm diameter attached to the shaft in the slicing unit.

3. Frame: The frame was made from 40 x 40 mm angle iron, with 385 mm height and 255 widths. The frame holds or supports the entire component of the machine.

4. Frame cover: was made from mild steel sheet of 2 mm thickness with 270mm length and the 281mm width.

5. Shaft: The shaft was made from mild steel rod with length 358 mm and 30mm diameter connected to the two pulleys to transfer power from the electric motor to the slicing unit.

6. Electric motor: The electric motor was used to drive the driven pulley and to provide the required shaft speed for slicing operation.

Figure 7: Sliced Ripe Plantain

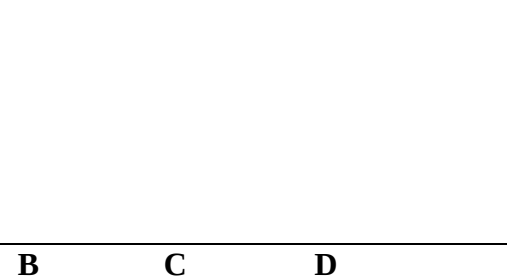

Figure 8: Sliced Unripe Plantain

4.0 RESULT AND DISCUSSION

Table 1: Unripe Plantain

Samples	A	B	C	D	
Initial Weight (Kg)	131.5	158.3	167.5	106.2	
Final Weight (Kg)	78.1	100.5	98.2	62.6	
Loss (Kg)	52.1	54.6	65.2	36.4	
Length (mm)	185	200	200	195	
Diameter (mm)	31.39	32.40	35.73	26.81	
Slicing Time (Hr)	0.133	0.167	0.167	0.233	
Slice Capacity (Kg/hr)	988.72	947.90	1,003	455.8	
Average					848.9

Table 2: Ripe Plantain

Samples	**A**	**B**	**C**	**D**	
Initial Weight (Kg)	122.4	101.6	139.5	103.8	
Final Weight (Kg)	44.8	42.0	40.3	54.6	
Loss (Kg)	59.0	46.8	91.6	48.3	
Length (mm)	175	170	190	175	
Diameter (mm)	30.42	28.62	29.89	27.89	
Slicing Time (Hr)	0.08	0.08	0.15	0.067	
Slicing Capacity (Kg/hr)	1,530	1,265	930	1,549.2	
Average					1,319

The above result shows that for the unripe plantain, slicing was done at a longer time for each of the replicates respectively but it was done at a lesser time for the ripe plantain samples. This could be attributed to the soft texture for ripe plantain which could have made slicing easier and faster. However, the time of slicing had no effect on the size, length and diameter of the samples.

Also, an appreciable amount of loss was observed while using the slicer for the unripe samples but this cannot be compared to the amount lost while slicing the ripe plantain samples. More than 40% of each of the samples were lost during slicing and this does not tell well of the economical value of the plantain slicer.

The efficiency of the plantain slicing machine is given by

$$\eta = \frac{QT - QU}{QT} \; x\; 100\%$$

Where:

η – Slicing efficiency (%)
QT – Total quantity of plantain sample (g)
QU – Quantity of waste or unsliced plantain (g)

CONCLUSION AND RECOMMENDATIONS

The performance evaluation of NCAM plantain slicer was carried out to analyse its output has been a rewarding exercise. Results from the performance evaluation have provided some data required to improve on the design and fabrication of the machine for effective slicing operation. However there was non uniformity in the size of sliced plantain, this might be due to the non-uniformity in application of force by the operator (manpower) and also the skill of the operator during the process.

NCAM slicer produced chips of 2mm in sizes which is good for crispier product, the literature and empirical evidence revealed that plantain chips of sizes up to 3mm (1/8 inch size) taste better and crispier, as a dessert than those bigger in size.

In future design and fabrication of NCAM plantain slicing machine, there is need to improve the machine's hopper to allow free fall of sliced plantain.

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