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DESIGN, CONSTRUCTION AND PERFORMANCE EVALUATION OF A PORTABLE SWEET POTATO SLICER

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ABSTRACT

This study focused on the design, construction and performance evaluation of a portable motorized sweet potato slicer. The components of the slicer include a feeding trough, frame, slicing disc, collection tray and power transmission unit. The machine was powered by a 1 hp electric motor. A 3 x 2 factorial experiment in a Randomized Complete Block Design (RCBD) was used to investigate the effects of operational speeds (312, 406 and 501 rpm) and tuber diameters (25-50 and 51-70 mm) on the performance of the machine in terms of slicing efficiency and machine capacity. The performance evaluation of the slicer was carried out in triplicates and ANOVA was used in evaluating the results. The results from the study showed that variations in operational speed had significant effect ($p \leq 0.05$) on slicing efficiency and machine capacity while effect of tuber size was only significant ($p \leq 0.05$) on capacity and not significant on the slicing efficiency. The slicing efficiency of the slicer increased from 74.4% to 94.1% and 76.0% to 96.4% for 25-50 mm and 51-70 mm tuber diameters respectively as the operational speed decreased from 501 to 312 rpm. The optimum rotational speed of the slicer obtained was 312 rpm at an average efficiency of 94.5% and capacity of 128.46 kg/h. The thickness of the slices produced from the slicer ranged from 2-4 mm. The machine helped to reduce drudgery associated with manual slicing of sweet potato.

KEYWORDS: Sweet potato, Operational speed, Tuber size, Slicing efficiency, Machine capacity.

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1. INTRODUCTION

Sweet potato (*Ipomoea batatas* L. Lam) is a tuber crop of the *Convolvulacea* family and *Solanales* order. It is a starchy root vegetable with a sweet flavor (Ravindran *et al*., 1995). Its cultivars produce tubers with a variety of flesh and skin colors. It contains some nutrients such as carbohydrate, protein, vitamins A and C as well as some essential minerals (Bengtsson *et al.,* 2010). It can be used for various purposes once it is harvested.

It can serve as fresh vegetable and as raw material which can be processed into other products or ingredients such as chips, flakes, flour and starch. It has several industrial potentials such as production of sweeteners, beverages, noodles and ethanol (Tewe *et al*., 2003).

Consumer demand for sweet potato is drifting away from fresh tubers to processed products around the world due to expanding urban populations, dietary variety and lifestyles that leave less time for preparing fresh products for consumption. This has resulted in ever increasing quantity of potatoes being processed to fulfill expanding demand for convenient foods and snacks (Daniel *et al*., 2009). These developments therefore, necessitate the commercialization of sweet potato production and mechanization of the unit operations involved in its processing.

Sweet potato tuber is highly perishable after harvest due to its high moisture level. This reduces its storability over a long time without considerable postharvest loss. Also, its production is highly seasonal, resulting in significant variations in the quantity and quality of the tubers in markets. Prompt processing of the tubers into some its products such as flakes, chips and flour with improved storage stability is therefore, necessary (Oyefeso and Raji, 2021). The tuber is subjected to various processing operations during its conversion into its various products. These processing operations include cleaning (wet and dry), material separation, slicing, drying, milling into flour and subsequent packaging.

Slicing is an important unit operation in the processing of sweet potato tubers. It is described as a size reduction process that involves the passage of a thin, sharp blade or knife through the tuber. Sweet potato tubers are usually sliced to achieve desired thickness before drying to extend their shelf life and reduce microbial activities (Owolarafe *et al*., 2007; Padmaja *et al.,* 2012). The traditional method of slicing the tubers in Nigeria and other developing nations involves placing the tubers on a flat board and cutting manually with a sharp knife to obtain desired thickness that depends mainly on the expertise of the individual involved. This method is harmful, time consuming, unsanitary and results in poor quality end-products especially where uniform thickness is required.

Several slicers have been developed for various crops with different degrees of success in their operations. Some of these slicers were designed for cassava tubers (Raji and Igbeka, 1994), plantain (Aremu and Fowowe, 2000; Onifade, 2016), some potato varieties (Chand *et al*., 2013; Hoque and Saha, 2017; Zin *et al*., 2021) and banana (Krantidip *et al*., 2020). Agbetoye and Balogun (2009) also developed a multi-crop slicer and its performance was evaluated with carrot, potato, onion and yam. Many of these slicers were automatically

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fed while some were fed manually. Limitations of some these previous designs include non-uniformity of the produced slices, high percentages of damaged products, complexity of the designs and operations, poor feeding mechanisms, sizes and costs of the machines. This study was therefore, aimed at developing a portable motorized slicer for Nigeria-grown sweet potato tuber with a view to reducing the drudgery involved in its processing.

2. MATERIALS AND METHODS

2.1. Design Considerations and Calculations

The materials used for the construction of components of the slicer were carefully selected to ensure portability in terms of size and weight. The different components were bolted together for ease of dismantling and maintenance. Stainless steel was used for the construction of the components in regular contact with the product so as to prevent contamination. The machine feeding trough was designed to accommodate 2 to 3 sweet potato tubers per time with each tuber of length in the range 30-100 mm and diameter 20-70 mm.

2.1.1. Load Stress of Compressive Spring

A helical compressive spring was used to feed the potato tubers into the slicing unit. The load stress of the spring was calculated according to Equation 1(Khurmi and Gupta, 2005):

$$\tau = K\left[\frac{8TD}{\pi d^3}\right] \tag{1}$$

where;

τ is shear stress of the compressive spring (calculated to be 6.4 MN/m^2),
T is force (compressive or torsional) acting on the spring (79 N), D is mean diameter of the spring (50 mm), d is wire diameter (5.5 mm) and K is stiffness factor which was determined to be 1.07 using Equation 2 (Khurmi and Gupta, 2005):

$$K = \frac{(4P-1)}{(4P+4)} + \frac{0.615}{P} \tag{2}$$

where;

P is the spring index which was calculated using Equation 3 (Khurmi and Gupta, 2005):

$$P = \frac{D}{d} \tag{3}$$

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The load deflection of the spring was calculated according to Equation 4 (Ismail *et al.*, 2016).

$$\delta = \frac{8TD^3n}{Fd^4} \quad (4)$$

where;

δ is spring deflection (m), n is the number of effective coils (which is 4) and F is modulus of rigidity for spring steel (80 MN/m^2).

2.1.2. Force Requirement for Potato Slicing

The force required by the slicing disc for slicing the sweet potato tubers was calculated using Equation 5 (Khurmi and Gupta, 2005):

$$G_f = \tau_s \times A_h \quad (5)$$

where;

G_f is the force required for shearing raw sweet potato tuber (calculated to be 80 N), τ_s is shear stress of the fresh sweet potato (455.138 kN/m^2) (Yusuf and Abdullahi, 2012) and A_h *is* area of the potato sample under shear (0.00177 m^2) which was calculated according to Equation 6:

$$A_h = \pi r^2 \quad (6)$$

where;

r is average radius of the targeted sweet potato (0.02375 m).

The angular velocity of the rotating disc was calculated using Equation 7 (Yusuf and Abdullahi, 2012):

$$\omega = \frac{2\pi N}{60} \quad (7)$$

where;

ω is angular velocity of rotating disc (32.68 rad/s) and N is rotational speed of pulley on the shaft (calculated to be 312 rpm).

2.1.3. Power Required by the Slicing Disc

The power requirement for slicing sweet potato was determined using Equation 8 (Onifade, 2016).

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$$T_c = G_f \times W_p \qquad (8)$$

where;

T_c is power required by the slicing disc for slicing the tubers (calculated to be 0.261 W), W_p is linear velocity of the slicing disc (3.27 m/s) which was determined from Equation 9.

$$\mathrm{W_p} = \omega \times \mathrm{P_t} \qquad (9)$$

where;

P_t is the radius of the slicing disc (0.1 m).

2.1.4. Power Rating of the Electric Motor

The power required by the electric motor to drive the designed portable sweet potato slicer was calculated using Equation 10 (Ikechukwu *et al*., 2014):

$$\mathrm{K_m} = T_c \times \mathrm{K_P} \qquad (10)$$

where;

K_m is power required by the electric motor (calculated to be 0.7 hp although 1 hp electric motor was used for the slicer) and K_p is the power factor (taken to be 2).

2.1.5. Shaft Design

The shaft diameter for the slicer having combined bending and torsional loads was calculated using Equation 11 (Khurmi and Gupta, 2005):

$$\mathrm{D}^3 = \frac{16}{\pi \times \mathrm{J_c}} \sqrt{(W_t Y_t)^2 + (P_b T_b)^2} \qquad (11)$$

where;

D is shaft diameter required (m), J_c is allowable bending stress for steel shaft with a keyway incorporated (determined to be 42 MN/m^2), W_t is stress combined shock and fatigue factor for torsion (taken to be 1.5, assuming that the shaft is to be loaded gently during operation), Y_t is torsional moment (Nm), P_b is stress combined shock and fatigue factor for bending (taken to be 1.0 for gradually applied or steady load) (Ikechukwu *et al*., 2014) and T_b is bending moment (determined to be 22.83 Nm).

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The shaft diameter was calculated to be 14.1 mm although a standard size of 20 mm was chosen for the machine.

2.1.6. Design of Pulley

Three sets of pulleys were designed for speed variation during performance evaluation of the slicer. Equation 12 (Khurmi and Gupta, 2005) was used in determining the speed variations with their respective pulley diameters.

$$\frac{N_2}{N_1} = \frac{D_1}{D_2} \tag{12}$$

where;

N_2 is prime mover speed (1420 rpm), N_1 is speed of the follower (calculated to be 312, 406 and 501 rpm for the three diameters), D_1 is diameter of the prime mover pulley (60 mm) and D_2 is diameter of the pulley on the follower shaft (170, 210 and 273 mm for the three speed levels).

2.1.7. Length of an Open Belt

The length of the belt for the machine was calculated according to Equation 13 (Obayopo *et al*., 2012). The length of the belts for the three pulley diameters were calculated to be 1040.6, 1110.9 and 1227.0 mm.

$$X = 2H + \frac{\pi}{2}(L + l) + \frac{(L-l)^2}{4H} \tag{13}$$

where;

X is length of the open belt (mm), H is centre distance between the two pulleys (335 mm), L is pulley diameter on the driver (170, 210 and 273 mm) and l is pulley diameter on the drive (60 mm).

The angle of contact was calculated using Equation 14 while the angle of wrap was evaluated using Equation 15 (Khurmi and Gupta, 2005).

$$\emptyset = \sin^{-1}\left[\frac{R-r}{H}\right] \tag{14}$$

$$\theta = (180 - 2\emptyset)\frac{\pi}{180} \tag{15}$$

where;

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θ is angle of wrap of an open belt (degrees), R is radius of larger pulley (m), r is radius of smaller pulley (m) and ∅ is angle of contact on the driver pulley (Khurmi and Gupta, 2005).

Linear velocity of the shaft was calculated using Equation 16 (Khurmi and Gupta, 2005).

$$v = \frac{\pi DN}{60} \tag{16}$$

where;

V is linear velocity (calculated to be 14.87 m/s), N is rotational speed of the selected electric motor (1420 rpm) and D is diameter of the designed shaft (0.2 m).

Belt tensions on the tight and slack sides were obtained according to Equations 17 and 18 (Khurmi and Gupta, 2005).

$$\frac{P_1}{P_2} = 10^{\left(\frac{\beta \times \theta}{2.3}\right)} \tag{17}$$

$$\mathrm{K_m} = (P_1 - P_2)V \tag{18}$$

where;

P_1 is belt tension on the tight side (calculated to be 88.1 N), P_2 is belt tension on the slack side (38 N) and β is the coefficient of friction between the belt and the pulley.

Isometric and exploded views of the sweet potato slicer are presented in Figures 1a and 1b, respectively.

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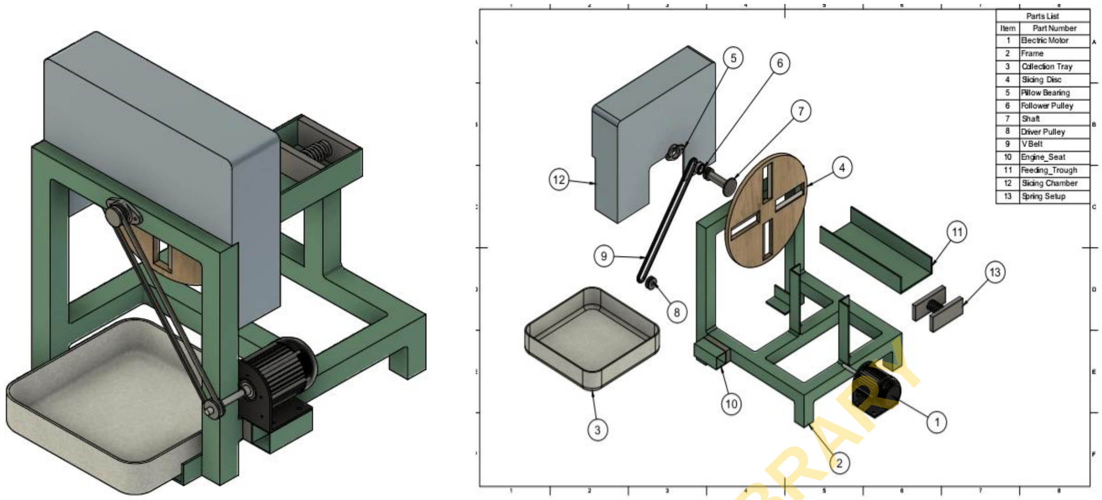

Parts List	
Item	Part Number
1	Electric Motor
2	Frame
3	Collection Tray
4	Slicing Disc
5	Pillow Bearing
6	Follower Pulley
7	Shaft
8	Driver Pulley
9	V Belt
10	Engine_Seat
11	Feeding_Trough
12	Slicing Chamber
13	Spring Setup

Figure 1: (a) Isometric view of the slicer (b) Exploded view of the slicer

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2.2. Description of the Sweet Potato Slicer

The portable sweet potato slicer consists of a frame, feeding trough, slicing disc with four blades, slicing chamber, collection tray, and the power transmission unit. The frame provides rigid support for other machine components. The feeding trough consists of a compressive spring which helps to push the tuber to be sliced towards the slicing chamber. The slicing chamber is a detachable rectangular compartment that houses the slicing disc with the four blades or knives which were welded to the slicing disc. The slicing disc was mounted vertically on the frame through the shaft which was supported by a pair of pillow bearings.

2.3. Performance Evaluation of the Sweet Potato Slicer

The performance evaluation of the slicer was carried at Crop and Fibre Processing Laboratory of the Department of Agricultural and Environmental Engineering, University of Ibadan, Ibadan, Nigeria. The white-fleshed sweet potato tubers for evaluating the performance of the slicer were bought from Bodija market, Ibadan, Nigeria. The moisture content of the fresh sweet potato tubers was determined using an oven dryer (Memmert UF 55, Germany, range +20 to +300 °C, up to 99.9 °C: 0.1/from 100°C: 0.5 accuracy) according to American Society of Agricultural and Biological Engineering standard (ASABE, 1993) as described by Nwajinka *et al*. (2020). The samples were dried at a temperature of 130℃ and weighed with the aid of an electronic weighing balance (Camry, model: EK5350, China, 5 kg max, 0.1 g accuracy) to determine the initial weight of the sample and the final weight after oven drying for 6 hours. The moisture content was computed using Equation 19 (Raji and Oyefeso, 2017).

$$\mathrm{MC_{db}} = \frac{W_w}{\mathrm{W_{dp}}} \times 100\% \tag{19}$$

where;

$\mathrm{MC_{db}}$ is moisture content (%, dry basis), $\mathrm{W_w}$ is the mass of water (g) and $\mathrm{W_{dp}}$ is mass of dry product (g).

The diameters of the sweet potato tubers used in this study ranged from 25 to 70 mm while the lengths ranged from 40 to 85 mm, similar to those reported by Oyefeso and Raji (2018). The tubers were peeled manually with a sharp stainless knife and the diameters of the peeled sweet potato were determined with the aid of a vernier caliper. The tubers were sorted into two groups based on their diameters (25-50 mm and 51-70 mm) to determine the effect of tuber sizes on machine performance. The machine was operated at three speed levels namely 312, 406 and 501 rpm which were obtained by varying the pulley diameters - to study the effect of speed on the slicing efficiency and capacity of the machine. The experiments were arranged in 3 by 2 factorial design and carried out in triplicates. The products obtained from the slicer collection tray were separated into two groups: neatly sliced product and the damaged slices, and weighed.

2.3.1. Slicing Efficiency of the Slicer

The efficiency of the slicer was calculated according to Equation 20 (Shittu *et al.*, 2017).

$$\xi = \frac{(\vartheta 1 - \vartheta 2)}{\vartheta 1} \times 100\% \tag{20}$$

where;

ξ is the slicing efficiency (%), ϑ_1 is the mass of the neatly sliced sweet potato tubers (g) and ϑ_2 is the mass of the damaged sweet potato slices (g).

2.3.2. Capacity of the Slicer

The capacity of the slicer was determined using Equation 21 (Shittu *et al.*, 2017).

$$G = \frac{D_h}{Y} \tag{21}$$

where;

G is machine capacity (kg/h), $\mathrm{D_h}$ is mass of sliced sweet potato (kg) and t is time taken for slicing (h).

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3. RESULTS AND DISCUSSION

3.1. The Developed Sweet Potato Slicer

Figure 2 shows the fabricated sweet potato slicer. The sweet potato tubers used for the evaluation were at average moisture content of 130±6.94% (dry basis). The average mass of the tubers used for each of the experiments was 312 g while the percentage of damaged potato slices ranged from 2.3% to 26.7%. The thicknesses of the slices produced from the slicer were within the range 2-4 mm and non-uniformity observed in diameters of sliced products was due to the irregularity in the shape of sweet potato tubers.

3.2. Effect of Speed and Tuber Size on the Machine Efficiency

Variations in slicing efficiency at different operational speed levels are presented in Figure 3 while Table 1 shows the ANOVA results of the effect of the operational parameters on the slicing efficiency of the machine at 5% level of significance. The slicing efficiency of the machine ranged between 74.4 and 94.1% for 25-50 mm tuber size range while it ranges between 76.0 and 96.4% for 51-70 mm tuber size range.

Figure 2: Fabricated portable potato slicer

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The slicing efficiencies reported in this study are similar to those obtained by Agbetoye and Balogun (2009) but higher than the values reported by Hoque and Saha (2017) probably due to the differences in the moisture content, maturity and varieties of sweet potato tubers used in the evaluation (Egbeocha *et al.*, 2016). The slicing efficiency increased with decrease in operational speed level. The highest (96.4%) and lowest (74.4%) efficiencies were obtained at 312 and 501 rpm respectively. The statistical analysis showed that the effect of speed levels was significant ($p \leq 0.05$) on the slicing efficiency while there was no significant difference ($p \leq 0.05$) between the slicing efficiencies obtained for different tuber size ranges. Non-significance of tuber sizes on slicing efficiency may be attributed to the relatively high moisture content of potato tubers which made it easy for the blades to cut through the sweet potato tubers irrespective of their sizes (Egbeocha *et al.*, 2016).

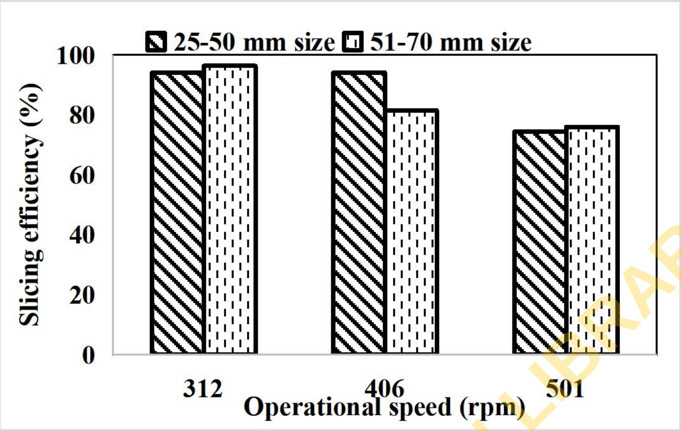

Figure 3: Variations in slicing efficiency with operational speed

Table 1: ANOVA for effects of speed and tuber size on slicing efficiency

Source	df	SS	MS	F-value	p-value
Model	4	1260.55	315.14	164.71	0.000
Linear	2	1207.99	603.99	315.68	0.000
A-Speed	1	1201.00	1201.00	627.70	0.000
B- Size range	1	6.99	6.99	3.65	0.078
Square	1	53.69	53.69	28.06	0.000
A^2	1	53.69	53.69	28.06	0.000
2-Way Interaction	1	0.40	0.40	0.21	0.655
AB	1	0.40	0.40	0.655	
Error	13	24.87	1.91		
Lack-of-Fit	1	4.07	4.07	2.35	0.152
Pure Error	12	20.81	1.73		
Total	17	1285.42			

S = 1.38323 *R^2 (actual) = 98.06%* *R^2 (adj.) = 97.47%* *R^2 (pred.) = 96.28%*
df – degree of freedom, SS – Sum of Squares, MS – Mean square

3.3. Effect of Speed and Tuber Size on Machine Capacity

Variations in machine capacity at different operational speed levels are presented in Figure 4 while Table 2 shows the ANOVA result of the effects of operational parameters on machine capacity at 5% level of significance. Machine capacity increased as

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operational speed and tuber size increased. The highest machine capacity (196.0 kg/h) was obtained at 501 rpm while the lowest capacity (89.0 kg/h) was obtained at 312 rpm for both tuber size ranges. The overall model shows that the effects of operational speed and tuber size-range on the capacity of the machine were significant ($p \leq 0.05$). The individual effect of each of the parameters namely operational speed and tuber size range was significant ($p \leq 0.05$) on the machine capacity while the interaction between the speed and the tuber size range on the capacity was not significant ($p \leq 0.05$). This indicates that effects of speed and tuber size-range on the capacity are not dependent on each other but each parameter affects the machine performance exclusively.

The most suitable operational speed was 312 rpm for sweet potato tubers of 51-70 mm diameter and the corresponding machine efficiency and capacity were 96.0% and 128.5 kg/h, respectively. It could therefore, be recommended that the slicer should be operated at a moderate speed on larger sized sweet potato tubers so as to obtain a relatively high efficiency and machine capacity.

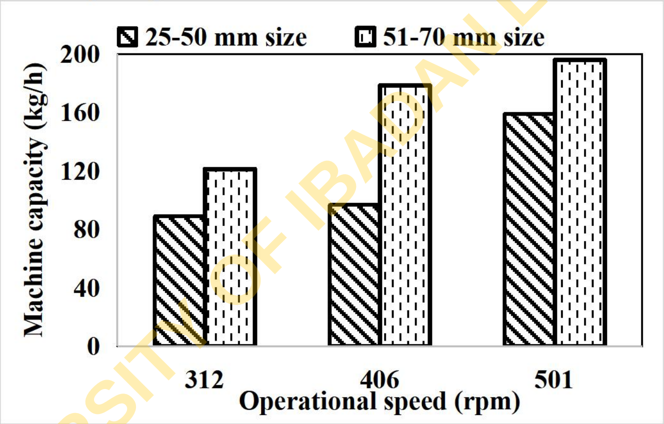

Figure 4: Variations in machine capacity with operational speed

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Table 2: ANOVA for effects of speed and tuber size on machine capacity

Source	df	SS	MS	F-value	p-value
Model	4	30854.6	7713.6	35.53	0.000
Linear	2	30823.0	15411.5	70.98	0.000
Speed	1	17906.1	17906.1	82.47	0.000
Tuber Size	1	12916.9	12916.9	59.49	0.000
Square	1	27.2	27.2	0.13	0.729
Speed*Speed	1	27.2	27.2	0.13	0.729
2-Way Interaction	1	0.2	0.2	0.00	0.979
Speed*Tuber size	1	0.2	0.2	0.00	0.979

Error	13	2822.5	217.1		
Lack-of-Fit	1	1776.4	1776.4	20.38	0.001
Pure Error	12	1046.1	87.2		
Total	17	33677.1			

S = 14.7349 *R^2 (actual) = 91.62%* *R^2 (adj.) = 89.04%* *R^2(pred.) = 84.14%*
df – degree of freedom, SS – Sum of Squares, MS – Mean square

4. CONCLUSION

A portable motorized sweet potato slicer was designed, fabricated and tested in this study. It can be concluded that slicing efficiency and machine capacity varied with variations in operational speed and tuber sizes. The optimum operational parameters obtained for the machine were rotational speed of 312 rpm and tuber sizes within the range 51-70 mm while the corresponding machine efficiency and capacity were 96.01% and 128.46 kg/h, respectively. Drudgery involved in manual slicing of sweet potato tubers can be reduced through the use of the developed slicer.

REFERENCES

Aremu, A. K. and Fowowe, S. O. (2000). Design and development of a manually operated slicing machine. *Nigeria Institute of Agricultural Engineering Journal*. 22: 30-35.

ASABE (1993). American Society of Agricultural and Biological Engineers (ASABE) Standard Moisture Measurement, S.358.2 (Dec 93).

Agbetoye, L. A. and Balogun, A. (2009). Design and performance evaluation of a multi-crop slicing machine. In: Proceedings of the 5th CIGR Section VI International Symposium on food processing, monitoring technology in bioprocesses and food quality management, Potsdam, Germany, 31 August - 02 September, 2009: 622-640.

Bengtsson, A., Brackmann, C., Enejder, A., Alminger, M. L. and Svanberg, U. (2010). Effects of thermal processing on the in vitro bioaccessibility and microstructure of β-carotene in orange-fleshed sweet potato. *Journal of Agricultural and Food Chemistry*. 58(20): 11090-11096.

Chand, K., Pandey, R. K., Shahi, N. C. and Lohani, U. C. (2013). Pedal operated integrated potato peeler and slicer. *Agricultural Mechanization in Asia, Africa and Latin America.* 44 (1): 65-69.

Daniel, C., Anton, H., Oscar, O. and Nebambi, L. (2009). Sustainable potato production: guidelines for developing countries, Food and Agriculture Organization of the United Nations. ISBN 978-92-5-106409-2.

UNIVERSITY OF IBADAN LIBRARY

Egbeocha, C. C., Asoegwu, S. N. and Okereke, N. A. A. (2016). A review on performance of cassava peeling machines in Nigeria. *Futo Journal Series (FUTOJNLS)*. 2(1): 140-168.

Hoque, M. A. and Saha, K. K. (2017). Design and development of a manual potato cum sweet potato slicer. *Journal of Science Technology and Environment. Informatics*. 5(2): 395-401.

Ikechukwu, I. B., Ugwuoke, I. C. and Muazu, Z. O. (2014). Design and fabrication of an electrically powered rotary slicer for raw plantain chips production. American Journal of Engineering Research. 3(4): 38-44.

Ismail, S. O., Ojolo, S. J., Ogundare, A. A. and Oke, P. K. (2016). Design and development of an improved plantain slicing machine. *Journal of Engineering Research*. 18(2): 19-27.

Khurmi, R. S. and Gupta, J. K. (2005). Textbook of Machine Design, Eyrasia Publishing House Ltd., Ram Nagar, New Dehli: 1096.

Krantidip, R., Pawar, P., Ukey, F., Pritam, D., Kaustubh, B., Rushikesh, B., Jadha, C. and Aniket, A. (2020). Development of fruit and vegetable slicing machine. *International Research Journal of Engineering and Technology*. 7(3): 1399-1404.

Nwajinka, C. O., Okonjo, O. E., Amaefule, D. O. and Okpala, D. C. (2020). Effect of microwave power and slice thickness on fiber and ash contents of dried sweet potato. *Nigerian Journal of Technology*. 39(3): 932-941.

Obayopo, S. O., Taiwo, K. A., Owolarafe, A. K. and Adio, S. A. (2012). Development of plantain slicer. *Journal of Food Science Technology*. 51(7): 1310-1317.

Oyefeso, B. O. and Raji. A. O. (2018). Estimating mass and volume of Nigerian grown sweet and Irish potato tubers using their geometrical attributes. *Adeleke University Journal of Engineering and Technology*. 1(1): 123-130.

Oyefeso, B. O. and Raji, A. O. (2021). Effective moisture diffusivity and activation energy of tannia cormels: influence of temperature, pre-treatment and slice thickness. *Nigerian Journal of Technology (NIJOTECH)*. 40(1): 1-12.

Owolarafe, O. K., Muritala, O. A. and Ogunsina, B. S. (2007). Development of an okra slicing device. *Journal Food Science and Technology*. 44(4): 426–429.

Padmaja, G., Sheriff, J. T. and Sajeev, M. S. (2012). Food uses and nutritional benefits of sweet potato. *Fruit, Vegetable and Cereal Science and Biotechnology*. 6(1): 115-123.

UNIVERSITY OF IBADAN LIBRARY

Raji, A. O. and Igbeka, J. C. (1994). Pedal operated chipping and slicing machine for tuber. *Journal of Agricultural Engineering Technology*. 2: 90-99.

Raji, A. O. and Oyefeso, B. O. (2017). Effect of moisture content and loading orientation on elasticity of cocoyam cormel during transit and storage. *Agricultural Engineering International: CIGR Journal*. 19(4): 193-199.

Ravindran, V., Ravindran, G., Sivakanesan, R. and Rajaguru, S. B. (1995). Biochemical and nutritional assessment of tubers from 16 cultivars of sweet potato (*Ipomoea batatas* L.). *Journal of Agricultural and Food Chemistry*. 43(10):2646–2651.

Shittu, S. K., Bello, M. and Dangora, N. D. (2017). Development of motorized tomato slicer. *Arid Zone Journal of Engineering, Technology and Environment*. 13(2): 197-208.

Onifade, T. B. (2016). Design and fabrication of a three-hopper plantain slicing machine. *American Scientific Research Journal for Engineering, Technology, and Sciences*. 17(1): 61-80.

Tewe, O. O., Ojeniyi, F. E. and Abu O. A. (2003). Sweet potato production, utilisation and marketing in Nigeria. The International Potato Center (CIP), Apartado 1558, Lima 12, Peru, and the University of Ibadan, Oyo State, Nigeria.

Yusuf, A. O. and Abdullahi I. (2012). Development and evaluation of a potato slicing machine. *Journal of Engineering and Technology*. 7(1): 22-28.

Zin, A. F. M., Mantari, M. S., Roslan, M. E. R., Indarah, M. E. R., Anuar, M. I. and Mohamad, M. (2021). Semi-automatic potato peeler and cutter: an initial development. *Multidisciplinary Applied Research and Innovation*. 2(1): 277-283.

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