DEVELOPMENT OF INDIGENOUS VEGETABLE LEAF (AMARANTUS HYBRIDUS) SLICING MACHINE

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ABSTRACT:

A vegetable leaf slicing machine was designed and fabricated using the locally available material to easy the hygienic slicing of vegetable leaf material and for prevention of injuries associated with manual process of using knife for the same purpose. The functional parts of the machine consists of operating handle, cutting blade assembly, cutter housing and a rotating shaft. The machine was tested with a slicing rate of 150 kg leafy vegetable per hour and an efficiency of 92 %.the result shows that the developed machine can be used for domestic and commercial purposes.

Key words: Vegetable leaf, Slicing, hygienic, Injuries

INTRODUCTION:

Green leafy vegetable are edible plant leaves that can help complete diet. They are typically rich in nutrients and fiber and low in calories and fat. The nutritional profiles of green leafy vegetables are generally associated with health benefits (Racheal, 2021).

According to Oguniye (2011) production and consumption of vegetables are very important because of their contribution to good health and as cheap source of minerals and vitamins needed to supplement people's diet which are mainly carbohydrate. Nigeria up till now is yet to achieve 5% total calorie intake of non-starchy vegetables recommended by food and agriculture organization.

Slicing is a cutting process for size reduction of vegetable that involves pushing or forcing a thin sharp knife to shear through the material intended to be sliced (Owolarafe etal 2007).In most of the preparation ways of leafy vegetables as food, slicing into very thin particles is required(Kahoade etal 2013).Nutrition expert have said that requesting vegetable sellers to slice it at the point purchase is unhygienic, warning that the practice can cause food poisoning(Angela,2022).In the past years, knives were the common tools

used for slicing and cutting vegetables to smaller size. The processing of large quantity of vegetable takes long and some cases, it causes injuries as a result of carelessness (Awili etal 2009).

Ikpoza (2021) confirmed that vegetable slicing with knife is known to be hazardous, increasing the number of people who get hurt while using knives in slicing their vegetables. Vegetables go through additional steps of washing, surfing, cutting or slicing and packaging into retail size containers prior to use or for sale. Slicing machine has become important equipment in the processing of vegetables (Ammonize etal 2022).

Agbonkhese (2020) reported that manual method of slicing vegetable is not hygienic and the risk associated with the process makes it dangerous. The study on Development of leafy vegetable slicing machine is aimed at solving the problem of injury, time wastage, ecliptic power supply and food contamination during manual slicing of leafy vegetables.

MATERIALS AND METHODS

Design consideration

In this design, high slicing efficiency, prevention of injury and food contamination were considered. Other critical consideration while designing the machine include: capacity of the machine, cutting force of slicing blade, availability and cost of construction materials, design of the frame to ensure structural stability and strong support for the machine.

Design analysis and calculation

Slicing blade is an important component of the machine. Stainless steel was used for the slicing blade because of its hardness and strong resistance to corrosion.

The rotating shaft is a functional part of the machine. It is connected to the handle which aid the blade to rotate in order to slice the vegetables.

The operating handle is connected to the shaft which rotate the slicing blade in order to cut the leafy vegetables to the required size.

Frame is the main supporting component that ensures structural stability of the machine.

Rotating shaft design

The slicer rotating diameter was obtained using the expression

$$T = \frac{\pi}{16} \times \tau_S \times d^2$$

$d = \sqrt[3]{\frac{16T}{\pi\tau_S}}$ mm (Verma,2008)

Where: T=twisting moment acting on the shaft (N-mm), $\tau_S = torstional\ shear\ stress\ in\ N/mm$

d = diameter of the shaft

$d=\sqrt[3]{\frac{308.7 \times 16}{3.1432 \times 40}} = 3400mm$

The diameter of the shaft is 3400mm

Capacity of the machine

This was determined using the mathematical expression given by

$C_{MC}=\frac{Q}{t}$ (Agbonkhese, 2020)

Where C_{MC} = capacity of the machine (kg/hr),

Q =weight of slice leafy vegetable materials (kg), t= time taken to slice the leafy vegetable material (hr).

$C_{MC}=\frac{150}{1} = 150kg/hr$

The blade Cutting force

The cutting force of the slicing blade is the force required to slice the leafy vegetables into smaller sizes. The force is expressed as:-

F_C = mg

Where: F_C= the cutting force of the slicing blade (N), m = mass of leafy vegetable per batch (kg) and g =the acceleration due to gravity (9.8m/s^2).

F_C= 150 9.8 = 1470 N (khurmi, 2005)

Cutting torque

The cutting torque is expressed as

$T_C = F_C$r (Khurmi, 2005)

Where: T_C = the cutting torque (Nm), F_C= the cutting force of the slicing blade (N), r = the radial arm of the cutting blade.

T_C = 1470 $\times$ 0.21= 308.7 Nm

The cutting torque applied on the blade is 308.7 Nm

PERFORMANCE TEST OF THE MACHINE

The performance of the fabricated leafy vegetable slicing machine was tested by feeding leafy vegetables samples of different lengths into the slicing unit of the machine. The sliced leafy vegetable lengths were measured and tabulated as shown in Table 1.

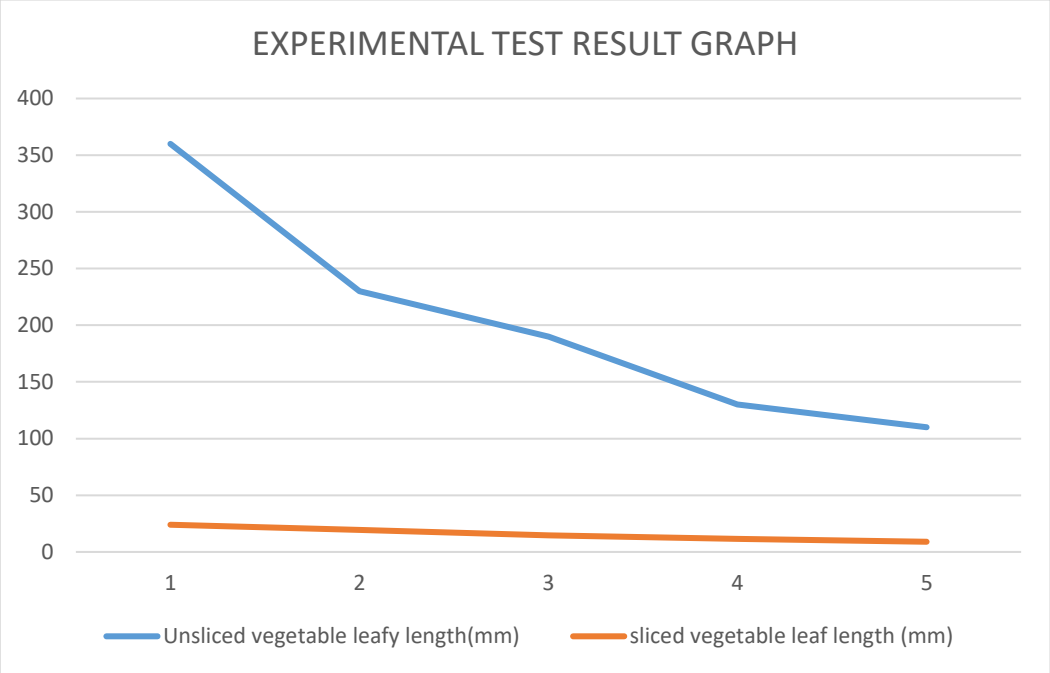

Table 1: Experimental test result

S/N	1	2	3	4	5
Unsliced leafy vegetable length(mm)	360	230	190	130	110
Sliced leafy vegetable length(mm)	24	19.5	14.5	11.5	9

SLICING EFFICIENCY OF THE MACHINE

The slicing efficiency of the machine is the original average size of the unsliced leafy vegetable minus the average size of the sliced materials per the original average size of the unsliced leafy vegetable. The efficiency can be expressed mathematically as

$$S_E = \frac{S_u - S_s}{S_u} \times 100\% \quad \text{(Ikpoza, 2021)}$$

Where S_E= Slicing efficiency (%), S_u=average size of the unsliced leafy Vegetable materials (mg), S_s=average size of the sliced leafy vegetable materials (mg).

$$S_E = \frac{204 - 15.7}{204} \times 100\% = 92.3$$

RESULTS AND DISCUSSION

The test results in table 1 above shows that the fabricated leafy vegetable machine performance is satisfactory. The machine slicing efficiency is 92.3% and the machine slicing capacity per batch is 150 kg/hr.

CONCLUSION

A leafy vegetable slicing machine was developed and its performance was satisfactory. The experimental result revealed that the fabricated machine has slicing efficiency of 92.3%.the result suggest that the fabricated machine can be used to slice large quantity of leafy vegetable efficiently with lesser demand of electrical energy.

RECOMMENDATION

1. Local production of the equipment should be encourage by government and non-government organization for job creation and better service delivery.
2. Vegetable sellers should be encourage to use the machine to safeguard them from injuries during slicing vegetable for buyers.
3. Alternative means of power supply to the machine can be in cooperated to ease the manual operation of the equipment.

REFERENCE

Racheal Ann, (2022), "*what to know about green leafy vegetables*"MedicalNewsToday, September 12,2022

Amonyeze Ahuna Onyinyechi, Aremu Kehinde Oludayo, Onwachekwu Amarachi Ihedinachi, Nduka Onyeka chuckwuebuka, Ojotule Ojomi ,Okafor Gabriel Ifeanyi,(2022) "*Manually operated leaf Slicer:Design,Fabrication and Performance Evaluation*" Africa Journal of Food Science and Technology. Vol 13,issue 5,2022.

Awili C.P.N, Omidiji B.V.,Awili I.I.,(2009), "*Design of Manual Vegetable Slicing Machine"* The Nigerian Journal of Research and Production .Vol.15 No.2,November,2009

Angela Onwuzoo, (2022), "*Slicing Vegetable at point of purchase leads to loss of vital nutrient, could cause food poisoning*"HealthWise, Shutterstock Production

Agbonkhese, K.A.,Omoikholo Frank.,Okojie Godwin, Okoekhian Leonard,(2020), "*Design and Fabrication of Leafy Vegetable Shreddding Machine*"International Journal of Advances in Scientific Research and Engineering, Volume 6,Issue 4 ,April,2020.

Ogunniyi L.T.,(2011),*Economic Efficiency of Leafy Vegetable Production in Oyo State,Nigeria,*Opinion and Report,Science Publication,Volume 3 ,Issue 1,2011

Ikpoza, E., Usiobaifo, E.J., Erhunmwun, I.D., (2021), "*Design and Fabrication of a Manually operated Leaf Slicing Machine* "Journal of Applied Science, Environment and Management,Volume 25.Issue 2, February ,2021.195-198

Owolarafe,O.K.,Muritala, O.A.,Ogunsina,B.S.,(2007),Development of Okra Slicing Device,Journal of Food Science and Technology,Volume 44,Issue 4,2007 p426-429

Verma,A.P.,(2008),A Textbook of Machine Design(SI Units) ,Published by S.K.kataria & Sons,Nai Saraka, Delhi. P 308-309

Kurmi,R.S., Gupta,J.K.,(2005) "A Textbook of Machine Design(SI Units) ,Published by Eurasia publishinmjkg House (PVT0 Ltd,Ram Nagar,New Delhi,2005

Kahandage,P.D.;Wathsala,R.H.G.R.;Pharmasena,D.A.N.,(2013), "Design ,Development and performance evaluation of a manually operated leafy vegetable slicing Machine for Domestic Use" 3rd Annual Research Symposium-2013,Rajarata University of Sri Lanka.p46-48

Fig 1. THE FABRICATED VEGETABLE LEAF SLICING MACHINE

Fig 2. THE UNSLICED AMARANTHUS HABRIDUS (VEGETABLE LEAF)

Fig 3 SIDE VIEW OF THE FABRICATED VEGETABLE SLICING MACHINE

Fig 4.THE SLICED VEGETABLE LEAF VIEW