

Design and Fabrication of a Cassava Processing Handling Machines

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Abstract: Cassava processing handling machines that involves cassava grating and cassava mash dewatering machines was designed, fabricated and tested. The machines which are easy to operate and maintain has the following components: hopper, grating chamber, discharged outlets, transmission system, power unit and the frame for the cassava grater, and the cassava mash dewatering machine has the hydraulic screw jack, the rigid frame, compression spring and the dewatering chamber. The cassava grater was powered by 2.0 kW, single phase, 1640 rpm electric motor. The grater speeds varied are 1550 rpm, 1450 rpm and 1350 rpm and the results from the performance evaluation of the grating machine showed a higher capacity, improved efficiency and best performance was obtained at 1450 rpm grater speed of grating capacity of 250.45kg/h, throughput of 235.5 kg/h and efficiency of 96.8 %. Also, the dewatering machine has capacity of 400 kg/h and dewatering efficiency of 97.4%. it is therefore, recommended for the producers of garri and cassava products.

Keywords: Design, Fabrication, Cassava, Processing Handling, Machine.

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I. INTRODUCTION

Cassava (*Manihot esculenta* crantz) Is a popular crop worldwide belonging to the family Euphorbiaceae. It is a tuberous root crop grown mainly on the tropical regions of the world such as Latin America, Sub-Sahara Africa and Asia (Ovat and oday, 2018). The ability to thrive in marginal soils and its drought tolerance have been widely acknowledged making it a reliable crop for many farmers. Specifically, Nigeria has been a world leading producer of cassava with an estimated annual production of 2.6 million tonnes from an estimated area of 1% million hectares of land (Agbetoye, 2005). Cassava is propagated by 20-30cm long cutting of the stem, spacing between plants is usually 1-1.5 meters and it is usually intercropped with beans, maize and other annual crops (Adetunji and Quadri, 2011).

Cassava can be used in various ways and each component of cassava plant from the leave to the root can be utilized in one way or the other. Cassava tubers can be processed into varieties of food for man. It is one of the most valuable staple food sources for about 500 million people around the world and tens of millions of people in the West African sub-region Adejumo *et al.*, (2011). It is also fast becoming a foreign exchange earner as an industrial raw material in the production of starch, animal feed, concentrate for drinks, adhesives, confectionaries, seasonings, biofuels and hydrolysates for pharmaceuticals (Philip *et al.*, 2004). However, harvested cassava tubers are

highly perishable and may deteriorate within two to three days after harvesting (Adzimah and Gbadam, 2009), thus the need for it to be processed immediately after harvest. Cassava processing therefore deserves more attention in order to meet the local and international demand for its product.

Proper processing and preservation of harvested produce reduce post-harvest losses and thus help to conserve food supply. Mechanization of cassava processing operations had played significant role in promoting timely processing of large quantity of cassava tubers before they get spoilt. Some of the various machines required for processing cassava tubers into different products are; peeling machine for cassava peeling, washing machine for tuber cleaning, grater for depulping, racks and sacks for fermentation, press for dewatering, sifter for sieving, frying machine for roasting and dryers for drying.

Along this line, a number of machines have been designed and developed to replace the traditional ones as reported by Ale *et al.* (2016). However, some of these machines are not always adoptable by local farmers due to high cost of the machine, lack of operating skills, non-availability of machine parts and some other constraints relating to the capacity and efficiency of machine. Most critical are the machines for grating and dewatering which have not sufficiently satisfied the small- and medium-scale processors.

In light of this, very simple, easy to operate, high throughput, highly efficient and economically affordable cassava processing handling machine that have grating and dewatering machines was designed and fabricated with locally available materials so as to improve on the mechanization of cassava processing through a streamlined workflow.

II. REVIEW OF RELATED WORK

➤ Overview of Cassava Grating Machine

Traditionally, cassava roots are converted into a mash or pulp by grinding done either by pounding with mortar and pestle or with the use of a hand grater made of perforated metal sheet. These materials rust quickly and are different difficult to keep clean. These methods not only make the products unsafe for consumption, but are slow, labour intensive and generally have low throughput, making their products unsuitable to meet market demands and standards (Okonkwo *et al.*, 2016; Kadurumba *et al.*, 2018; Nnanna *et al.*, 2023; Abama *et al.*, 2024).

Many research efforts in developing cassava processing machines to meet local and international demands of cassava product have resulted in the production of several prototypes with different efficiencies and quality performance levels Darlene *et al.*, (2019). Odebode (2011) in the research conducted on appropriate technology for cassava processing in Nigeria highlighted several key techniques that can be enhance efficiency of cassava processing machines and recommended that the farmers be trained in the use of these improved processing equipment such as the vibrating sieve, abrasive peeler, motorized grater, drum drier and screw jack, so as to reduce processing time, labour cost, product quality and improve the overall cassava value chain in Nigeria.

The work of Agbetoye *et al.* (2006) on the development of indigenous machinery for cassava processing and fruit juice production resulted in significant improvement in the processing capacities, throughputs and efficiencies of grating and dewatering machines. Recommendations were made for the improvement and adoption of these machines. Yusuf *et al.* (2019) designed and fabricated a simple pedal operated cassava grater for rural dwellers using locally sourced materials. The grating efficiency and capacity of the grater were reported to be 90.91% and 103.7 kg/h, respectively. The grater was suitable for grating cassava tubers in rural areas where electricity and petrol are not readily available. However, despite this improvement, the machine is still operated by human power which relatively limits its capacity and efficiency.

An improved cassava grating machine was designed and fabricated by Adetunji and Quadri (2011). The new grater design incorporated features that increase the surface area for grating which significantly reduced the time for processing the cassava and has a higher throughput when compared to the traditional graters. However, the machine is suitable for small-scale production and needed to be scaled-up. Ndaliman (2006) developed a cassava grating machine

that focused on having dual operational mode that allows the machine to be powered either electrically or manually. The design addresses the lack of electricity supply that is prevalent in the rural areas. The design also minimized the labour and time required in processing the cassava tubers. Efforts are still required to improve on the usability and safety of the machine.

Another design and production of a powered cassava grating machine by Ugwuoke and Ikechukwu (2023) is also dual operational mode, the machine is powered electrically using electric motor or mechanically using a gasoline engine. The work focused on using locally sourced materials for the machine construction to make it affordable by both small- and medium- scale processors. The modified grating machine was reported to achieved a production rate of 454.55 kg/hr which is significantly higher than the existing models, but the overall machine cost and maintenance is still a constraint for small-scale farmers.

Development of mobile cassava grating machines by Aideloje *et al.* (2018) enhanced the movement to different locations of use, making it favourable to rural farmers who lack access to electricity. The mobile cassava grater also has substantial higher efficiency when compared to the traditional method. However, there are concerns about its long-term durability under rigorous use in rural setting. The initial cost required to purchase the machine could still pose a barrier for small-scale farmers. A double-action cassava grating machine was designed and evaluated by Oriaku *et al.* (2015) focusing throughput and efficiency in processing cassava tubers of difficult weights. The machine achieved average grating efficiency of 86.23% and a grating rate of 730.8 kg/hr, indicating its ability to handle large cassava efficiently with low mass loss. However, the machine's performance is limited to freshly harvested cassava tubers with a moisture content range of 68.2 - 77.8%, which may restrict its usability in certain conditions. The machine cost is also high.

A double- barrel cassava granting machine was designed, fabricated and evaluated by Nwadinobi *et al.* (2023) to enhance processing efficiency. The result of its performance indicated that the double-barrel machine has significant higher performance on machine throughput capacity and efficiency when compared with the single-barrel counterpart. However, despite its suitability for large-scale cassava processing, there are operational limitations such as wear and tear during prolonged use and the need of regular maintenance coupled with the initial high cost of the machine.

➤ Overview of Cassava Mash Dewatering Machine.

Dewatering of cassava mash is another critical process in cassava processing and it is aimed at reducing moisture content for better preservation and processing. Traditionally, dewatering and fermentation is done by using stones and logs as weights to press excess water out of bagged cassava mash which are then left to drain and ferment for a few days. These techniques are time consuming, unhygienic, labour intensive, full of drudgery and characterized with

very low output (Okonkwo *et al.*, 2016). Various techniques and machines have been developed to enhance this process, each with its own advantages and limitations.

The presses that uses the screw mechanism is common due to their simplicity, durability and low maintenance. The design typically features a rotating screw within a cylindrical barrel, which compresses the cassava mash against a screen, allowing the liquid to flow out while retaining solid residue. Studies indicated that the screw presses can significantly improve the efficiency of cassava processing compared to traditional methods. However, they have notable drawbacks such as significant manual labour, lower pressure and lower efficiency when compared with hydraulic operated presses (Kolawole *et al.*, 2011; Precoppe and Komlaga, 2020).

Hydraulic press method has shown to be more effective in achieving moisture content reduction in the shortest time. It can be hand-powered using hydraulic Jack or motor-powered using hydraulic pump. Though the motor-powered offered increased efficiency and reduced drudgery when compared with the hand-powered hydraulic press, the motor-powered hydraulic press is more complex and requires higher capital and operational cost (Kolawole *et al.*, 2011)

An innovative equipment for cassava dewatering by Precoppe and Komlaga (2020) uses a chain-hoist mechanism to mechanically dewater cassava mash, in the bid to address the challenges of the screw and hydraulic presses. Though the innovative press was quite effective, its throughput and manufacturing cost are only suitable for large-scale operation.

Considering the problems and constraints of many of the machines already developed, very simple, easy to operate, high throughput, highly efficient and economically affordable cassava processing handling machine that have grating and dewatering machines was designed and fabricated with locally available materials.

Mass of the grater = density $\times$ volume of the grater.

Hence, volume of the grater, V_g was calculated using equation 3.1

$$= \pi r^2 h \quad (3.1)$$

- *Determination of the Velocity of the Grating Drum Shaft.*

Velocity of the grater, V_s was determined using equation 3.2

$$= \pi d n \quad (3.2)$$

- *Determination of the Forces Acting on the Grater Drum.*

Forces (F_c) acting on the grater cylinder drum is given by equation 3.3, according to Kier and Jesal (2015);

III. DESIGN AND MATERIAL CONSIDERATION

- *The Following Factors were Considered in Designing the Machine and Selecting the Materials:*

- **Size and weight:** The weight per unit area of the chosen materials is negligible so that the machine can easily be transported from one location to another.
- **Machinability:** The materials selected were the types that can easily worked on and can be cut into various shapes
- **Availability:** This is the accessibility of the materials selected for the machine. This will help when the need to replace or repair any of the machine components.
- **Maintenance:** All materials selected are considered for easy of maintenance and possible replacement in case of damages.
- **Power requirement:** The machine was considered to be powered through electric motor.

- *Design Analysis*

- *Determination of Mass of the Grating Drum*

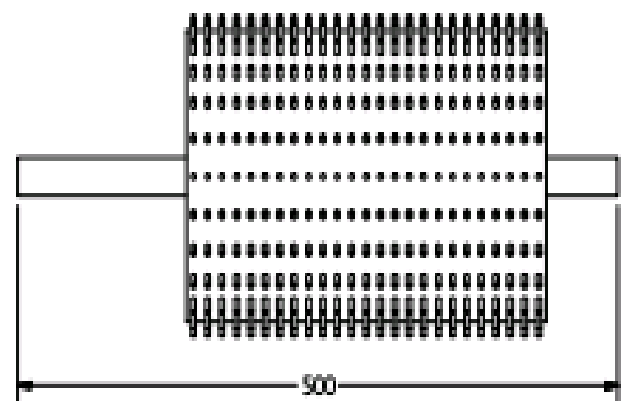


Fig 1 Grater Drum Schematics

$$F_c = V \cdot \rho \cdot g \quad (3.3)$$

- *Determination of the Torque (T) on the Grater Shaft*

This is the force required to turn the shaft of the grater, it is calculated using equation 3.4 Abubakar *et al.*, (2015)

$$T = F_c \times r \quad (3.4)$$

- *Determination of Power (Ps) Required to Drive the Grater Shaft*

This is determined using equation 3.5

$$P_s = T \times \omega \quad (3.5)$$

- *Determination of Grater Shaft Speed Ratio.*

This was calculated using equation 3.6 according to Khurmi and Gupta (2017);

$$N_1 D_1 = N_2 D_2 \quad (3.6)$$

- *Design of Cassava Grater Shaft Diameter*

The shaft diameter was calculated using equation 3.7 Khurmi and Gupta (2017);

$$d^3 = \frac{16}{\pi \tau} \sqrt{(K_b M_b)^2 + (K_t M_t)^2} \quad (3.7)$$

➤ Machine Drawing

The isometric and exploded drawings of the cassava handling machines were presented in Figures 3.2-3.5 respectively.

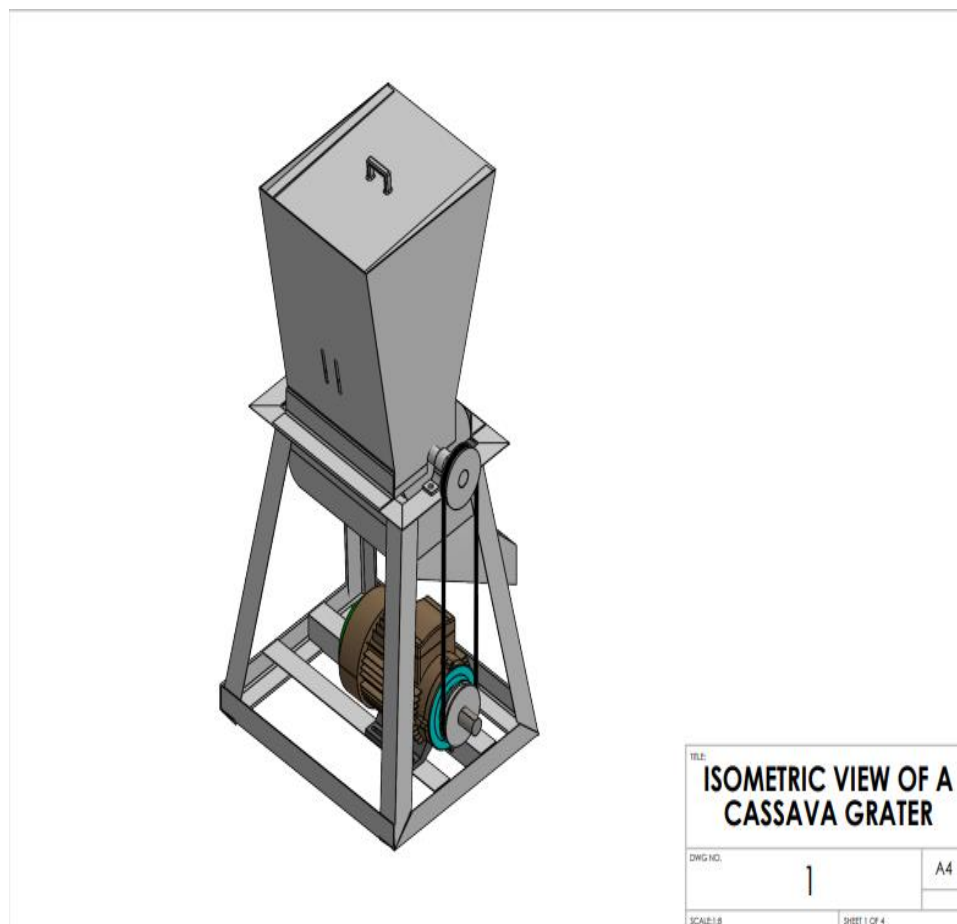


Fig 2 Isometric Drawing of the Cassava Grater

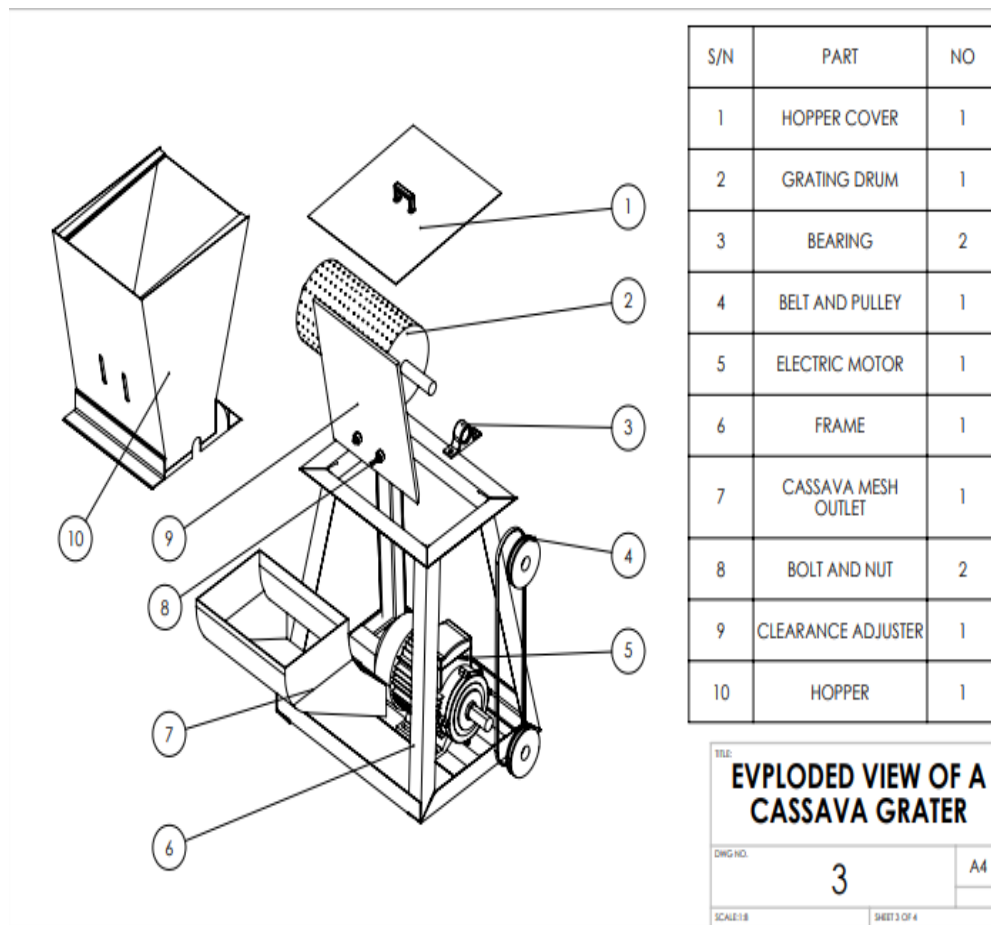


Fig 3 Exploded Drawing of the Cassava Grater

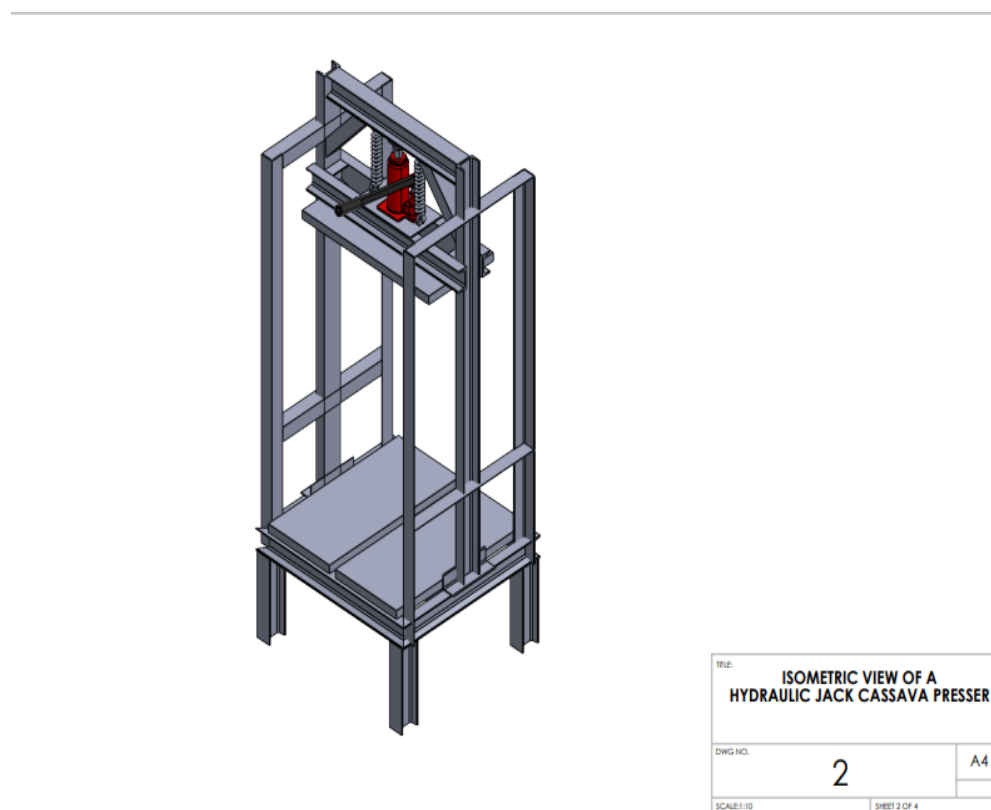


Fig 4 Isometric Drawing of Cassava Mash Dewatering Machine

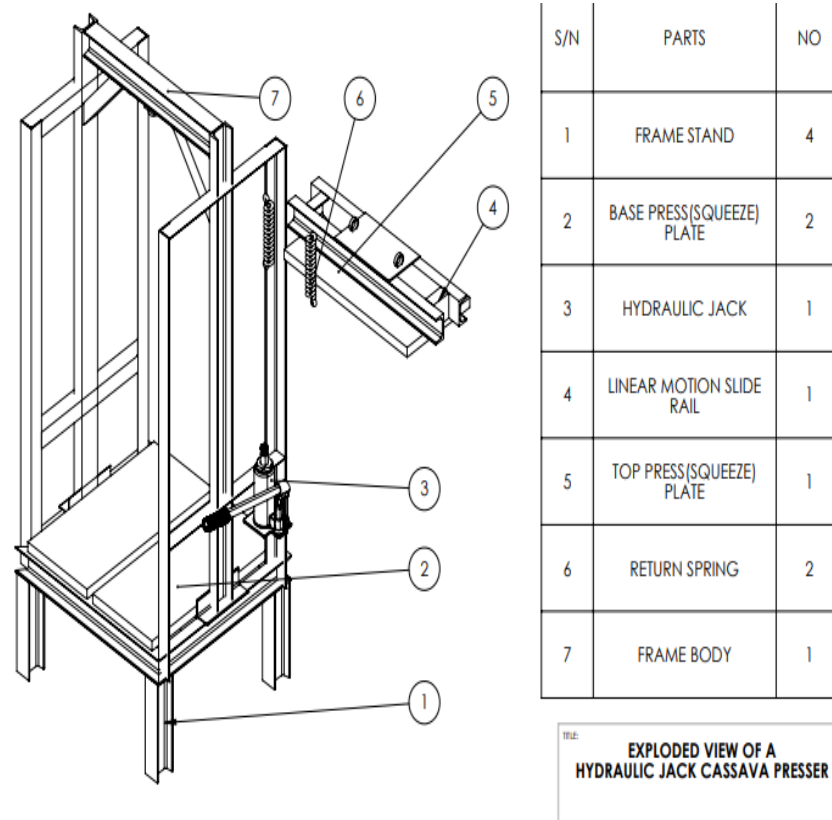


Fig 5 Exploded Drawing of Cassava Mash Dewatering Machine



Fig 6 Pictorial View of Cassava Grater and Mash Dewatering Machine

IV. RESULTS AND DISCUSSION

➤ Results

• Effects of Grater Speeds on Grater Capacity

Three grater speeds (1350, 1450, 1550) rpm were tested against two improved (TMS 30001, TMS 30555) and one local (Odogbo) cassava varieties based on its recommendation Olutayo and Agbetoye (2022). The

capacity of the grater increased as the speed increases in all the three varieties. The two improved varieties increased significantly against the local variety (Figure 4.1). The grater has its highest capacity (250.45 kg/h) at 1450 rpm with TMS 3001 cassava variety while the lowest capacity (182.44 kg/h) at 1550 rpm was recorded with local variety.

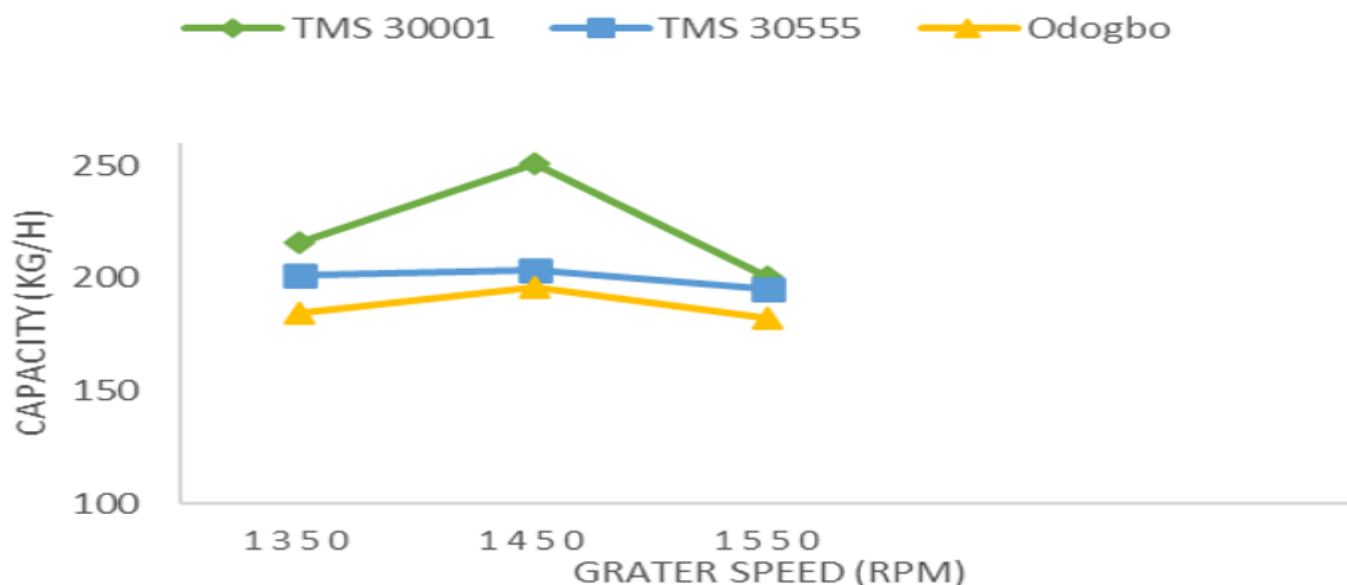


Fig 7 Effect of Grater Speeds on Capacity

• Effects of Grater Speeds on Throughput

The three grater speeds against the three cassava varieties was tested on the throughput of the grater, the three speeds have the same trend (Figure 4.2) on the three cassava

varieties. Increased in speed increases the throughputs in all the three varieties, may while, TMS 30001 cassava variety performed better (108 kg/h) at 1450 rpm grater speed.



Fig 8 Effects of Grater Speeds on Throughput

• Effect of Grater Speeds on Efficiency

The Efficiency of the grater increased on the three cassava varieties tested as the grater speeds increases (Figure

4.3). Maywhile, at 1450 rpm, TMS 30001 has the better efficiency (96.8 %) over other varieties.

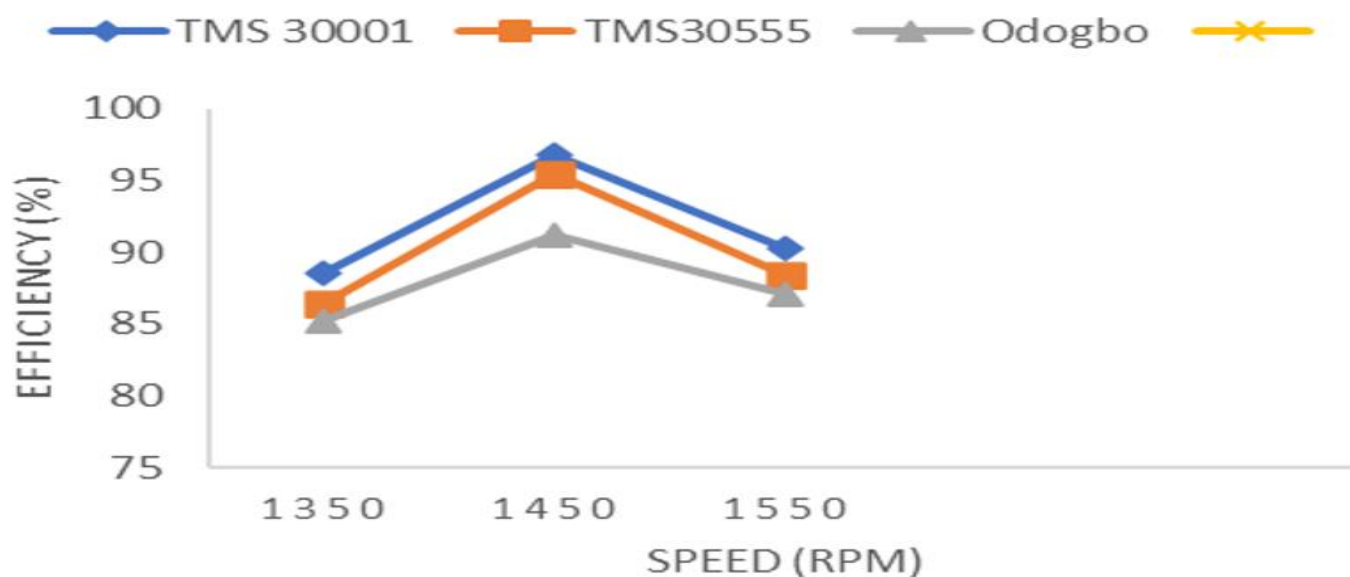


Fig 9 Effect of Grater Speeds on Efficiency

• *Effect of Applied Load, Process Time, Moisture Content and Efficiency on the Product*

Five trials were carried out on the cassava dewatering machine to determine the process time, the moisture content (wb) of the product, the weight of the dewatered cassava mash and the efficiency of the machine. Ten tonnes (98,100 N) of manual pumping jack was used constantly in dewatering the cassava mash with initial moisture content of 74%wb, the process time are 60,80,100,120, 140 minutes.

The moisture content obtained after dewatering ranged from 44-58%wb, while the product obtained ranged from 88.38-99.08 kg of the dewatered cassava cake (Figure 4.4). The efficiency of the dewatering machine ranged from 78.1 – 95%. The 44-45%wb recommended moisture content Ovat and Odey (2018) was achieved at 120 minutes process time with 95% efficiency of 88.38 kg of dewatered cassava mash.

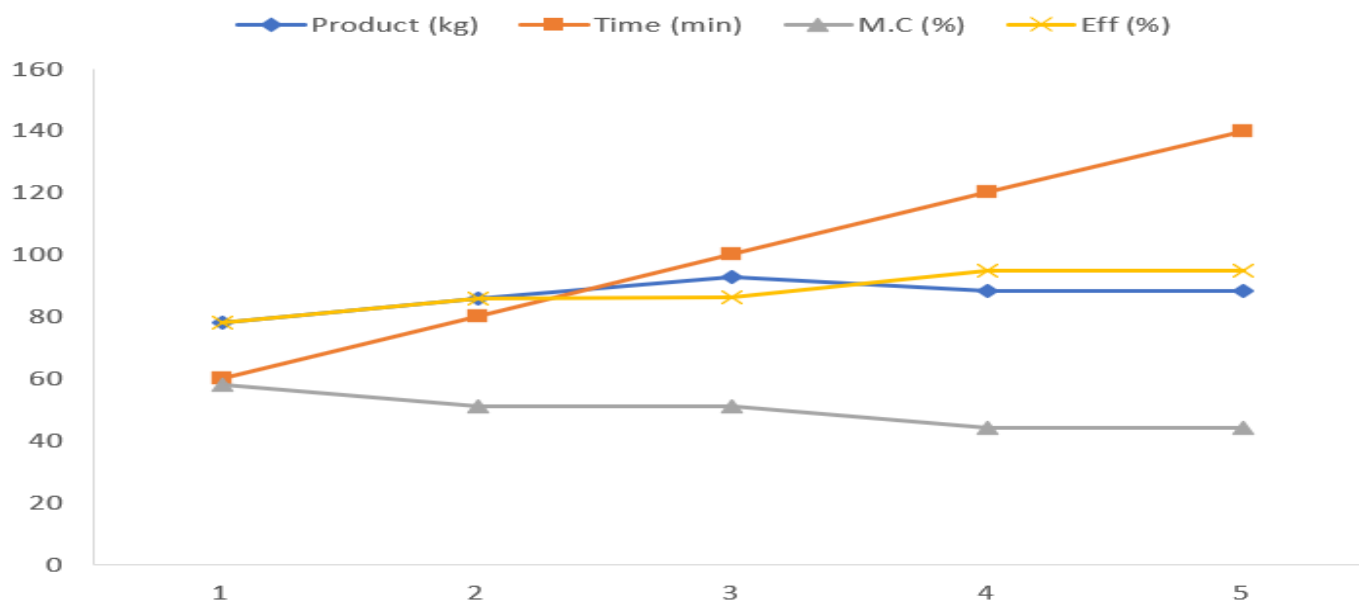


Fig 10 Effect of Applied Load, Process Time, Moisture Content and Efficiency on the Product.

V. CONCLUSION

Cassava processing handling machines that involves cassava grating and cassava mash dewatering machines was designed, fabricated and tested. The three grater speeds varied are 1550 rpm, 1450 rpm and 1350 rpm and the results from the performance evaluation of the grating machine

showed a higher capacity, improved efficiency and best performance was obtained at 1450 rpm grater speed of grating capacity of 250.45kg/h, throughput of 235.5 kg/h and efficiency of 96.8 %. Also, the dewatering machine has capacity of 400 kg/h and dewatering efficiency of 97.4%. it is therefore, recommended for the producers of garri and cassava products.

REFERENCES

- [1]. Abama, O., Onoriode, E., Orhorhoro, E. K and Ebunilo, P. O. (2024). Development of an Automated Cassava Grating Machine. NIPES-Journal of Science and Technology Research 6(3), 99-114
- [2]. Adejumo, A. O. D, Oradugba O.B, Ilori T. A, Adenekan M. O (2011). Development and Evaluation of a Cassava Chipping Machine. Journal of Raw Materials Research, 3:1-7.
- [3]. Adetunji, O. A. and Quadri, S. A. (2011). Design and fabrication of an improved cassava grater. The Pacific Journal of Science and Technology. 12(2), 120-128
- [4]. Adzimah, S. K and Gbadam, E. K (2009). Modification of the Designs of Cassava Grating and Cassava Dough Pressing Machines into a Single Automated Unit. European Journal of Science. Res, 38(2), 306-314
- [5]. Agbetoye, L. A. S (2005). Improving the Technology of Cassava Harvesting and Processing Mechanization for Food Security in Nigeria. Proceedings of the International Conference on Science and Technology. Federal University of Technology, Akure, Nigeria, 196 – 205.
- [6]. Agbetoye, L. A. S., Ademosun, O. C., Ogunlowo, A. S., Olukunle, O. J., Fapetu, O. P. and Adesina, A. (2006). Developing Indigenous Machinery for Cassava Processing and Fruit Juice Production in Nigeria. In Proceedings from the International Conference on Advances in Engineering and Technology.
- [7]. Aideloje, V. E., Okwudibe, H. A., Jimoh, A. Z., and Olawepo, B. B. (2018) Development and Utilization of Mobile Cassava Grating Machines in Nigeria. Journal of Environmental Issues and Agriculture in Developing Countries, 10(3), 168-180.
- [8]. Ale, M. O., Olutayo, L.A. and Ologunagba, F. O. (2016). An Approach to Developing Indigenous Farm Machinery for Cassava Processing Technology in Nigeria; Rufus Giwa Polytechnic, Owo. Experience. Poster presented at the World Congress on Root and Tuber Crops held in Nanning, China from Jan. 10 – 22, 2016.
- [9]. Darlene, U. E., Guillermo, P. P., Michelle O. S. and Jane S. M. (2019). Design, Fabrication and Performance Evaluation of Motor-Operated Cassava Grater. Mindanao Journal of Science and Technology. 17, 227-241
- [10]. Kadurumba, C.H., Ogunsola, T.M. and Nwogu-Chibuike, C.G. (2018). Design Modification of a Cassava Dewatering Machine. Nigerian Research Journal of Engineering and Environmental Sciences 3(1), 18-31
- [11]. Kolawole, O. P., Agbetoye, L.A.S. and Ogunlowo, A.S. (2011). Evaluation of cassava mash dewatering methods. Journal of Bioinformatics and Sequence Analysis, 3(2), 23-30.
- [12]. Ndaliman, M. B. (2006). Development of Cassava Grating Machine: A Dual-Operational Mode. Leonardo Journal of Sciences. 9, 103-110
- [13]. Nnanna, I., Mbabuike, I. U., Christian, A.U. and Ikechukwu, O.N. (2023). Design and Development of a Modernized Cassava Grating Machine. Asian Journal of Advanced Research and Reports. 17(1), 9-16
- [14]. Nwadinobi, C. P., Ezeaku, I. I., Uwandu, T. C., Iheadigwu, W. and Ihejirika, K. (2023). Development of a Double Grating-Barrel Cassava Grinding Machine. International Journal of Engineering and Modern Technology (IJEMT), 9 (3), 15-25
- [15]. Odebode, S.O. (2011). Appropriate Technology for Cassava Processing in Nigeria. Journal of Agricultural Science and Technology, 11(2), 123-130.
- [16]. Okonkwo, U. C., Onwukwe M., Oriaku E. C. and Okafor C. E. (2016). Performance Evaluation and Optimization of Single Barrel Cassava Grating Machine on Selected Fresh and Stored Cassava Species. IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE). Volume 13, Issue 4. PP 31-38
- [17]. Olutayo, L.A and Agbetoye, L.A.S. (2022). Performance Evaluation of Grating and Dewatering Machine, *International Journal of Computational Engineering Research (IJCER)*. ISSN(e): 2250-3005, Vol. 12. www.ijceronline.com
- [18]. Oriaku, E. C., Agulanna, C. N., Ossai, E. N., Odenigbo, J. O., & Adizue, U. L. (2015). Design and Performance Evaluation of a Double Action Cassava Grating Machine. Journal of Emerging Trends in Engineering and Applied Sciences (JETEAS), 6(3), 196–203.
- [19]. Ovat, F. A., and Odey, S. O. (2018). Development and performance evaluation of a motorized gari sieving machine. European Journal of Advances in Engineering and Technology, 2018, 5(7), 459-465
- [20]. Phillips, T.P., Taylor, D.S., Sanni, L., and Akoroda, M.O. (2004). A cassava industrial revolution in Nigeria: The potential for a new industrial crop. The Global Cassava Development Strategy. [ftp://ftp.fao.org/docrep/fao/007/y5548e/y5548e00.pdf](http://ftp.fao.org/docrep/fao/007/y5548e/y5548e00.pdf)
- [21]. Precoppe, M., and Komlaga, G. (2020). Innovative equipment for cassava dewatering. Technical Report. Natural Resources Institute, University of Greenwich, London. <https://gala.gre.ac.uk/id/eprint/34856/>
- [22]. Ugwuoke, I. C. and Ikechukwu, I. B. (2023). Design and Production of a Powered Cassava Grating Machine. International Journal of Innovative Science and Research Technology. 8, (5), 1222-1226
- [23]. Yusuf, K.O., Akpenpuun, T. D. and Iyanda, M. O. (2019). Design and Fabrication of a Simple Pedal Operated Cassava Grater Suitable for Rural Dwellers. Journal of Applied Sciences and Environmental Management. 23 (6), 1007-1011