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Design and Construction of an Integrated Garri Processing Plant

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Abstract: Garri is one of the most consumed foods in Nigeria today and it is majorly processed manually. This research focuses on the design, fabrication and testing of an integrated garri processing plant. It is made up of majorly the peeling/ washing, grinding, pressing, sieving, and frying units. The total time for the production of the garri is a combination of time for peeling, grating, pressing, sieving as well as frying and it is an average of 35.27mins. The efficiency of the machine on the average of three trials was found to be 70.5%
Keywords: Garri, Peeling, Grinding, Press, Frying and Sieving

I. INTRODUCTION

In the majority of the world's developing countries, cassava is a significant source of carbohydrates. The crop can be processed in Nigeria into products including garri, lafun, paki, pupuru, fufu, and cassava grit for animal and human consumption [1]. It can be either boiled or pounded and served with soup in Ghana. [1]Coincidentally, the governments of the two countries had already begun implementing presidential initiatives to promote exports and enhance cassava production for domestic use. As a result, a policy was started in the Nigerian bakery business in 2004 to create bread using cassava and wheat flour at a ratio of 1:9. In addition to being used as a food source for humans, cassava is also used to make alcohol [2].

As a potential alternative to fossil fuel, it has been discovered that alcohol may be extracted from sugarcane and cassava. Massive amounts of cassava are needed by China, and more and more of cassava's industrial potential is being uncovered every day on the Nigerian market. For instance, India has been successful in replacing 40% of its gasoline with ethanol, and the Congo has achieved 30% of bread production using cassava flour. [3]

To satisfy the local and global demand for cassava products, cassava processing thus merits serious consideration. Peeling, grating, boiling/parboiling, drying, milling, and screening, extrusion, and frying are some of the unit activities used in the processing of cassava. [4]While most of the procedures outlined above have been effectively automated, cassava peeling continues to be a significant global problem for design engineers active in cassava processing. The product of multiple prototypes with quality performance and relatively low peeling efficiency is the result of research efforts in this field. The reason for this is that cassava tubers come in a variety of sizes and odd forms.

Because there aren't many high-quality mechanized garri processing facilities in Nigeria, for example, engineers and manufacturers there are constantly looking for ways to enhance current designs. By definition, a model is unreachable in the time and space available, yet it is added last. This never-ending search is what creates a process that is justifiable. Humans and other species need healthy system settings to survive. Environmentally friendly chemical engineering, environmental resources management, and environmental protection are methods of reducing human influence. [5] [6]

A machine for peeling cassava was designed and manufactured by [7]. The cassava peeling machine was created using a manufacturing approach that uses locally accessible materials and reduces the overall relative cost of production. Peeling drum, shaft frame, chuck, and handle assembly make up the entire device. When the machine's performance was tested, it was discovered to have an average efficiency of 65%.

Roasting fermented, dewatered cassava mush produces garri, a gelatinized, granular, dry, and gritty foodstuff. In many African nations, particularly Nigeria [8,9], it is by far the most widely consumed and sold variety of cassava. It is typically consumed as a stiff paste called eba that is mixed with hot water and eaten with stews as a main meal or as a snack8 that is mixed with cold water in between meals. With other minerals having only minor nutritional importance, garri is a decent source of energy and fiber [10]

II. MATERIALS SELECTION AND METHOD OF PRODUCTION

A. Materials Selection

The materials used for manufacturing the integrated garri processing plant were sourced locally in order to reduce the overall production cost. The materials majorly includes; stainless steel, mild steel, hard wood, conveyors belts, transmission belts, bolts and nuts, electric cables, heat resistant electric cables, contactors, bearings, hydraulic press, heating elements, electric motors, speed regulator, electronic temperature controller, thermostats, heat resistant fibre etc. The materials were specially selected with consideration for strength, local availability, durability, cost, affordability, replaceability and reliability.

B. Method of Production

The peeling of the cassava tubers is carried out as they impinged on the spikes created on the rotating drum due to the frictional force generated between the tubers and the spikes as they both move against one another. The spikes are of different heights created in no specific or particular order. Washing of the cassava takes place simultaneously with the peeling in a tank fitted to the rotating drum. The peeled and washed cassava tubers are at thereafter transferred to the grinding unit for grinding. After the grinding process is completed the cassava mash is conveyed to the pressing unit by means of conveyors where it is dewatered to a dry state with very little amount of moisture. The dried cassava mash is thereafter moved to the filtering unit where it is filtered and later transferred to the frying unit fitted with heating elements for frying, which is the last stage of the production processes.

The basic units of the integrated garri processing plant are peeling, grinding, pressing, filtering/sieving and frying. The processes of manufacture of each of the units majorly comprised of the following; designing, measurement, cutting, welding and fabrication, finishing, assembling, testing.

C. Peeling and Washing Units

The peeling unit and the washing units are fitted together. The units comprised majorly of a rotating galvanised steel cylindrical drum and a galvanised steel water tank for washing the cassava tubers as the cylindrical drum rotates. The galvanised steel rotating drum is perforated with spikes of varying lengths of 2mm to 5mm meant for peeling the cassava tubers as they impinged on the spikes. The drum is fitted to a centralised shaft that is driven by a varying speed electric motor with the aid of two pulleys and a vee-belt. The drum is partially submerged in a water tank designed for holding water meant for washing the cassava tubers so as to be able to simultaneously carried out the functions of both peeling and washing of the cassava tubers as it rotates within the water tank. The husks are eliminated from the unit through the perforated holes on the drum. The peeled cassava tubers are evacuated manually through an opening created along the surface of the peeling drum. See figure 1 below.

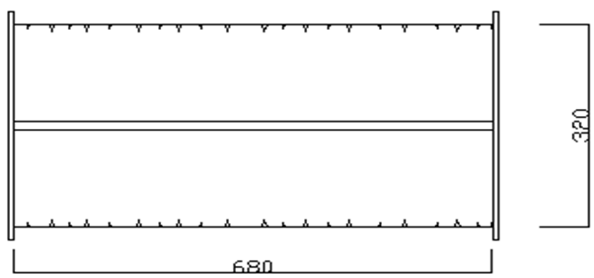

Fig1: Peeling Unit

D. Grating Unit

This unit consists of (i) a hopper (ii) Grater (iii) an electric motor and (iv) a shaft. (v) A slot mechanism. The hopper for receiving the peeled and washed cassava tubers is made of stainless steel. The stainless steel is first of all marked and measured with the aid of marking and measuring instruments and later followed by cutting and joining. The grater is made from a galvanised steel sheet. The galvanised steel sheet is first measured, marked and then cut to size. Very fine holes with spikes are at this point perforated on the galvanised steel sheet and thereafter, firmly wrapped around as well as fitted to a smoothly carved circular log of hard wood connected to a shaft driven by an electric motor with the aid of a vee-belt and two pulleys. The grinded cassava mash falls under gravity through an opening for discharge into a container that is attached for onward movement to the press unit. See fig 2.

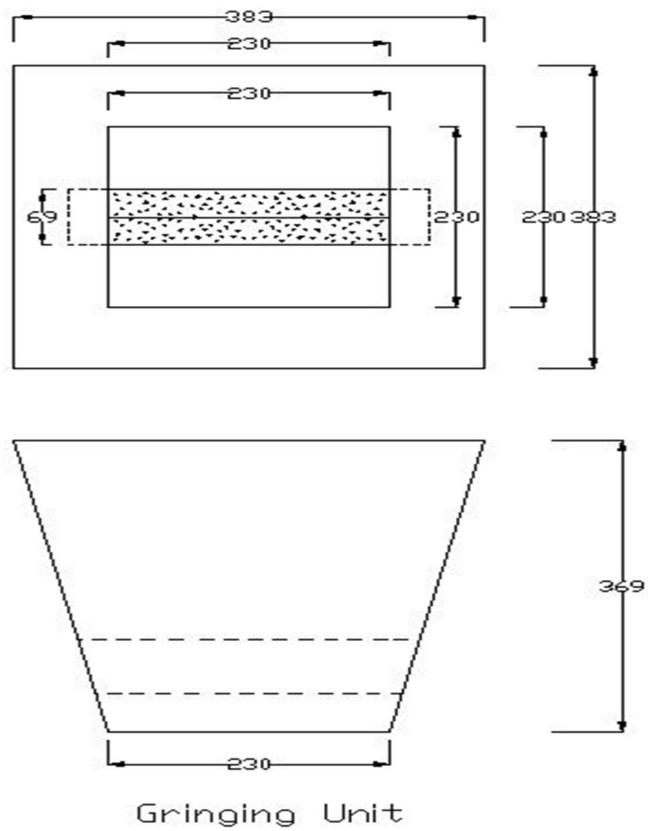

Fig 2: Grating Unit

E. Pressing Unit

The pressing unit is comprised of a hydraulic press and a rugged frame support structure. The hydraulic press is mounted on the rugged metallic frame support. The hydraulic press consists of a large cylinder containing hydraulic oil with a large piston and a hydraulic motor. The hydraulic press was bought already made from the market, while the frame support structure was fabricated using mild steel. The various parts of the frame support were first of all measured and marked and thereafter cut to the required sizes and then welded together. The hydraulic press was mounted vertically on frame structure that serve as support for the hydraulic press as well as a housing for the bags of mashed cassava that are to be dried. See Fig 3.

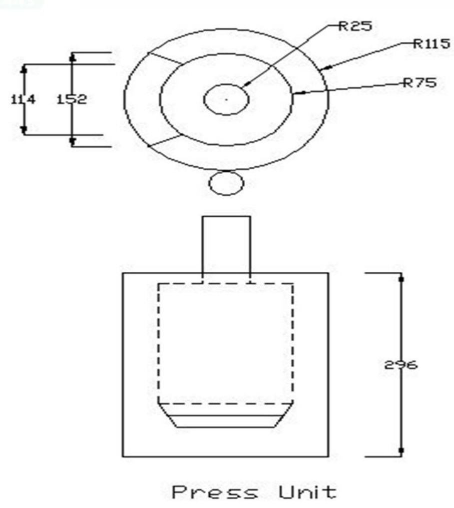

Fig 3: Press Unit

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F. Sieving Unit

The sieving unit is comprised of a sieve, camshaft, a rotating shaft, variable speed electric motor and a cylindrical vessel with an opening for moving sieved cassava to the next stage. The shaft and the cams are made of mild steel. Pieces of mild steel are cut and welded to the mild steel shaft at various points or positions to form the camshaft. The sieve was made from a galvanised wire mesh of an average size of 1.53mm. The wire mesh was measured and cut to the required size and thereafter fitted to a stainless steel container for holding the dried moistened cassava mash. The sieve is mechanically vibrated by the cam welded on the shaft. The camshaft is attached to a pulley which is connected to a variable-speed electric motor. The sieve with an average size of 1.5mm is vibrated and fine moistened particles of the dried mashed cassava falls beneath the sieve and are transported to the frying unit. See fig 4.

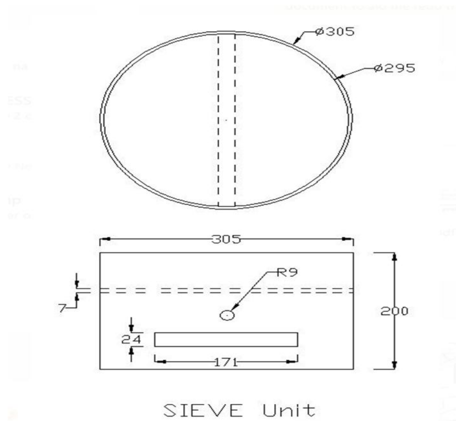


Fig 4: Sieve Unit

G. Frying Unit

The frying unit is comprised majorly of the following; heating element, frying drum, electric motor, electronic temperature control, electronic speed regulator, electric motor motion direction switch control and speed indicator, variable gear box, contactor, bearings, Lagging material and a stirrer. The frying drum is simply a cylindrical stainless steel measured and cut to the required size. The frying drum was laced with heating elements that were bought already made from the market with heating capacity of between 150^0 to 200^0. The stirrer is made up of a 40mm diameter shaft with blunt blades that turn the dried cassava mash until it is properly cooked or fried into the finished product called garri. The stirrer is powered by an electric motor.

The electric motor with the variable gear box attached to it is mounted at the base of the frame with the small pulley connected to the electric motor shaft. A belt is used to connect the big pulley to the small pulley before tightening the bolts and nuts of the electric motor to the base to get the required belt tension. The contactor and speed indicator switch are mounted on a control panel box. The electric motor motion direction switch control and speed indicator are connected to the contactor with an electric cable. The electronic temperature control is also connected with a cable to the contactor while the electronic temperature control is connected to the heating element. Wires are connected from the electronic temperature control to the thermocouple and the thermocouple is screwed into a 10mm nut attached to the frying drum to sense its temperature and display it on the temperature control. Other wires are connected from the contactor to a 3 phases electric power supply because the electric motor is a 3 phases motor. See Fig 5 and Fig 6.

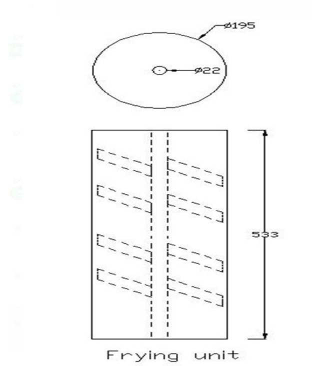


Fig 5: Frying Unit

H. Assembling of the Various Processing Units

After all the processing units were fabricated, they were sequentially positioned and assembled. Firstly, the combined peeling and washing units were positioned followed by the grating unit then by the pressing unit. The hopper of the grating unit and the pressing chambers of the pressing units are manually fed with the peeled/washed cassava tubers and bagged cassava mash respectively. Thereafter the sieving unit is positioned next to the pressing unit and finally followed by the frying unit with. See fig 6.

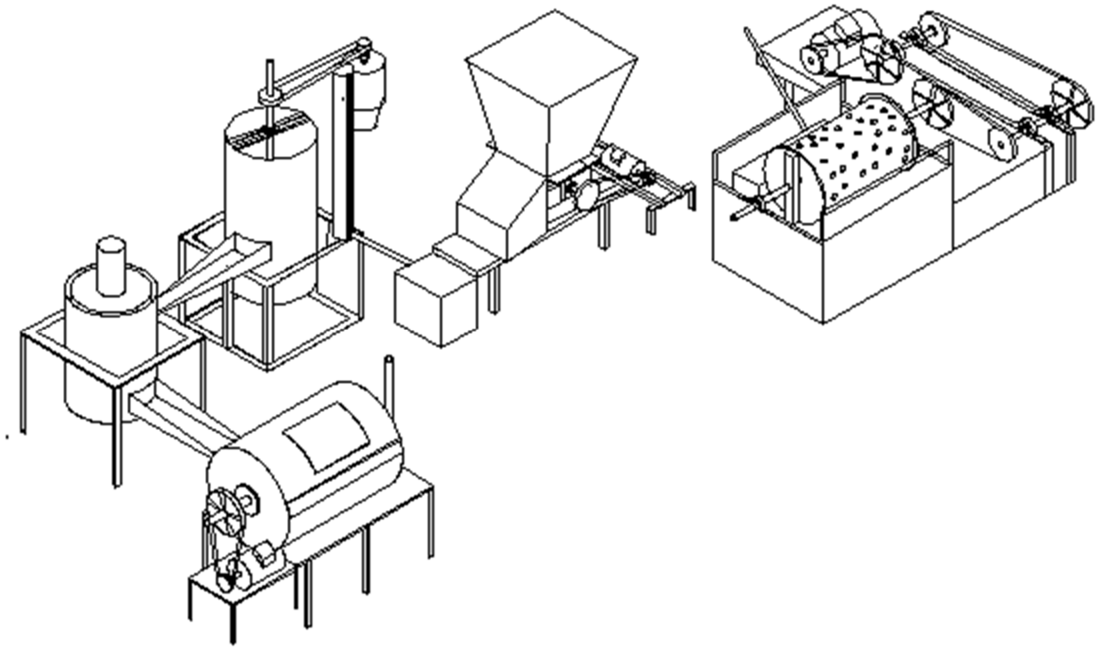


Fig 6: Isometric View of Garri Processing Plant

III. TESTING

Table 1 below is contains the mass of cassava in proportion of 10kg was tested on the garri processing plant. The 10kg mass was fed into the peeling unit and the time to complete the garri production was measured. The total time for the production of the garri is a combination of time for peeling, grating, pressing, sieving and frying for the three trails are 36.01mins, 34.33mins and 35.4mins. The efficiencies of the machine after three trails of 10kg cassava tuber loading, resulted in an average efficiency of the plant to be 70.5%

Table1 Evaluation of Efficiency of the Garri Processing Plant on the Bases of Three Trials of Three different set of 10kg Cassava Tubers Input

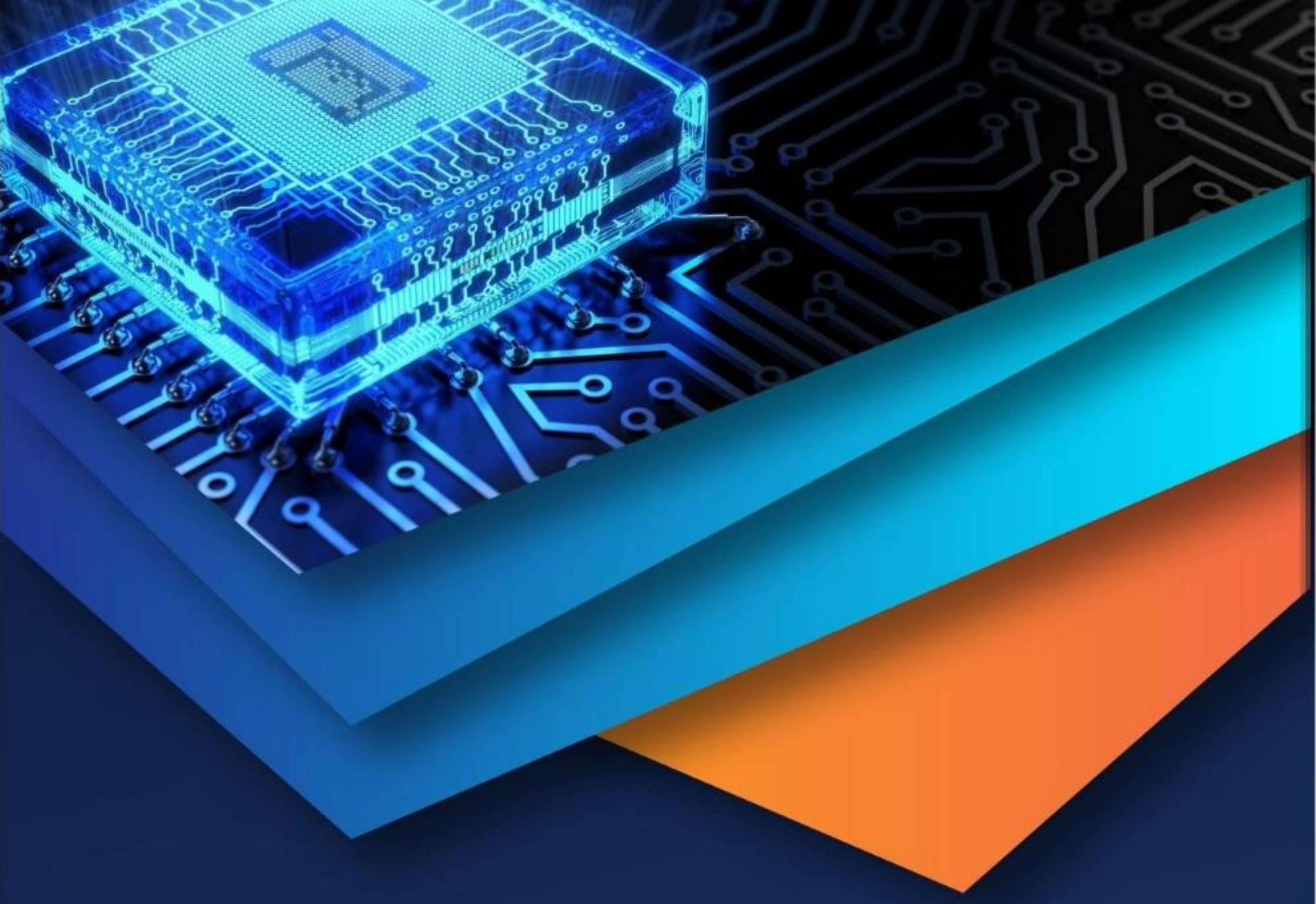
S/N	Processes	Trial 1			Trial 2			Trial 3		
		Input mass (kg)	Output Mass (kg)	Time (Mins)	Input mass (kg)	Output mass (kg)	Time (Mins)	Input mass (kg)	Output mass (kg)	Time (Mins)
1	Peeling/ Washing	10	8.9	7.2	10	9	7.13	10	9.1	7.12
2	Grating	8.9	8.6	6.6	9	8.5	5.57	9.1	8.5	6.28
3	Pressing	8.6	8.0	10	8.5	8.1	9.12	8.5	7.9	10.11
4	Sieving	8.0	7	5.21	8.1	7.5	5.8	7.9	7.5	5.01
5	Frying	7.4	7.0	6.42	7.5	7.1	6.31	7.5	7.1	6.12
6	Efficiency (%)	70		36.01	71		34.33	71		35.4

IV. CONCLUSION

This design and fabrication of the garri processing plant demonstrated that the processed cassava, known as Garri, was determined to be high-quality and free of stones. The outcome is intriguing since it would support the goal of this study, which is to reduce the issues traditional processors face and perhaps even enhance the output of high-quality gari This work would serve as a model for resolving issues faced by conventional Gari processors or automating the cassava processing process. It would also be possible to boost Gari production. With this, a cassava processing facility was effectively constructed for any production that was market-oriented. 10kg cassava tuber when fed into the peeling unit processed the cassava to garri in a time of 35.27minutes on a machine efficiency of 71.5%.

REFERENCES

[1] Ikegwu, O. J., Nwobasi, V. N., Odoh, M. O., Liedinma, N. U., 2009. Evaluation of pasting and some functional properties of starch isolated from some improved cassava varieties in Nigeria. Afr. J. Biotechnol. 8, 2310-2315
[2] Adetan, D.A., Adekoya L.O. and Aluko, O.B. (2003).Characteristic of some properties of cassava root tubers. Journal of Food Engineering 59: 349 – 353
[3] Howeler, R.H., Watananouta, W. and Tran Ngoc Ngoan (2004). Farmers decide. A participatory approach to development and dissemination of improved cassava technology that improve yield and prevent soil degradation. In: Proceedings of 13th International Society of Tropical Root Crops held in Arusha Tanzania.
[4] Odigboh, E. U. (1983). Cassava Production, Processing and Utilization. In. Chan
[5] Olukunle O. J. and Oguntunde P. G. (2008). Analysis of Peeling Pattern in an Automated Cassava Peeling System. Nigerian Journal of Technological DevelopmentVol.6 No. 1&2 41-52
[6] Rufus O. C,1 and Odo F . (2018) Analysis of Garri Frying Machine Manufacturing in Nigeria: Design Innovation: Advances in Science, Technology and Engineering Systems Journal Vol. 3, No. 6, 403-411
[7] Himanshu M, Nihal B, Yash N, Danish K, Labhesh P,. Shakebuddin M (2022): Review on Design and Fabrication of Multi-Sieve Sand Sieving Machine: International Research Journal of Engineering and Technology (IRJET). Volume: 09 Issue: 05
[8] Abdulkadir Baba Hassan (2012) Design and Fabrication of a Cassava Peeling Machine: IOSR Journal of Engineering (IOSRJEN) ISSN: 2250-3021 Volume 2, Issue 6 PP 01-08
[9] Olukunle, O.J. and Oguntunde, P.G. (2007). Analysis of peeling pattern in an automated cassava peeling machine. Nigerian Journal of Technological Development 6 (1 & 2): 41 – 52.
[10] Akinyemi, J. O. and Akinlua. (1999). Design, Construction and Testing of Cassava Grater. International Journal of Tropical Agriculture. 17(1-4); pp103-108.



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