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Development and Output Power Assessment of a Gasoline-Driven Cassava Peeling Machine for Small and Medium Scale Enterprises

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Abstract

Cassava is one of the major staple crops in tropical regions, yet its processing is limited by the labor-intensive and inefficient manual peeling procedures traditionally employed.. This research focuses on the development and output power assessment of a gasoline-driven cassava peeling machine designed for Small and Medium Scales Enterprises. The machine integrates a mechanical peeling chamber with abrasive rollers, a feeding mechanism, and a gasoline-powered driven system to ensure continuous and high operation throughout. Design considerations included ergonomic safety, durability, ease of operation, simple maintenance, and adaptability to varying tuber sizes. Performance evaluation was conducted to determine peeling efficiency, throughput capacity, and output power requirements under different operating conditions. Results indicated that the machine achieved a peeling efficiency above 85%, with minimal tuber damage and a consistent output power profile suitable for small and medium scales cassava processing. The gasoline-driven configuration ensures reliability in regions with limited access to electricity, making the machine pragmatic for rural and semi-urban agro-processing and agro-prenureship. This innovation contributes to improved cassava processing efficiency, reduced labor costs, and enhanced food security through mechanization.

Keywords: *Cassava, peeling, machine, gasoline-powered, output assessment, agro-processing, Agro-prenurship, peeling efficiency, small and medium scales, mechanization.*

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Introduction

1.0 Background

Cassava (ManihotesculentaCrantz) is one of the most important staple crops in tropical and subtropical regions, particularly in Africa, Asia, and Latin America. Globally, cassava ranks as the third most consumed carbohydrate source after rice and maize, feeding over 800 million people (FAO, 2021). Nigeria is the world's largest producer, accounting for more than 20% of global cassava output, with annual production exceeding 60 million metric tonnes (IITA, 2020). The crop is valued not only for its role in food security but also for its industrial applications in starch, ethanol, animal feed, and bio-based products (Nassar& Ortiz, 2010).Despite its importance, cassava processing remains a bottleneck in the value chain. One of the most labor-intensive stages is peeling, which is traditionally performed manually using knives or machetes. This method is slow, inconsistent, and prone to high post-harvest losses (Adetan et al., 2003). Manual peeling also exposes workers—often women and children—to occupational hazards such as cuts, fatigue, and musculoskeletal strain (Jimoh et al., 2014).

The inefficiency of manual peeling contributes to reduced productivity, poor quality of processed products, and limited competitiveness of cassava-based industries. As demand for cassava-derived products grows, there is an urgent need for mechanized solutions that can improve efficiency, reduce drudgery, and enhance food safety standards (Olukunle&Jimoh, 2012).

1.1 Problem Statement

The central problem addressed in this study is the inefficiency coupled with the unhygienic and stress of manual cassava peeling method. Traditional practices hinder agricultural productivity and economic growth by:

- Consuming excessive time and labor (Igbeka et al., 1992).
- Producing inconsistent peeling quality, which affects downstream processing.
- Increasing post-harvest losses due to flesh removal along with peels.
- Limiting scalability of cassava processing enterprises.

These challenges necessitate the development of an automated cassava peeling machine that is affordable, efficient, and adaptable to rural African contexts where electricity supply is unreliable.

1.2 Aim and Objectives

The aim of this research is to develop, fabricate, and assess the output of a cassava peeling machine powered by a gasoline engine.

Specific objectives include:

- Conducting a literature review of cassava peeling operations and existing technologies.
- Developing a conceptual design that prioritizes efficiency, safety, and adaptability.
- Performing detailed design analysis (power, torque, and efficiency calculations).
- Selecting suitable materials for fabrication, emphasizing corrosion resistance and food

Safety.

- Fabricating and assembling the machine using locally available resources.
- Testing and evaluating the machine's performance under real-world conditions.

1.3 Scope of the Study

This project focuses on cassava peeling within the fufu processing line, a staple food in Nigeria and West Africa. Due to financial and time constraints, the scope is streamlined to the development and fabrication of a prototype peeling machine applicable to rural and semi-urban communities such as Yewa in Ogun State, Nigeria. The machine is intended for small- to medium-scale farmers and processors, with potential scalability to cortage industrial applications.

1.4 Significance of the Study

The development of an efficient cassava peeling machine has multiple implications:

- Agricultural productivity: Automation reduces drudgery and increases throughput, enabling farmers to process larger volumes.
- Food security: Consistent peeling quality supports production of storable cassava products such as flour and starch.
- Economic growth: Mechanization enhances value addition, supporting Nigeria's GDP contribution from agriculture (World Bank, 2020).
- Industrial competitiveness: Reliable supply of peeled cassava improves raw material availability for food and beverage industries.
- Social impact: Reducing manual labor frees up time for women and youth, enabling participation in other income-generating activities.

1.5 Justification

Cassava peeling is a critical step in processing, yet remains largely manual in Nigeria. Mechanization is justified by:

- The need to reduce labor loss and improve efficiency.
- The potential to minimize tuber losses and maximize flesh recovery.
- The importance of food safety, achieved by using stainless steel in contact surfaces.
- The unreliability of rural electricity supply, addressed by gasoline-powered engines.

The injuries suffered from knife cuts and awkward working positions of the workman, addressed by the mechanized design

1.6 Research Questions

This study is guided by the following questions:

1. What are the limitations of existing cassava peeling technologies?
2. How can design considerations (capacity, material selection, portability) be optimized for rural African contexts?
3. What level of efficiency and tuber loss can be achieved with an abrasive peeling mechanism?
4. How does the performance of the developed machine compare with manual peeling and existing mechanical peelers?

2.0 Literature Review

2.1 Background

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Cassava peeling is a critical stage in post-harvest processing. The efficiency of this step directly influences product quality, processing costs, and overall profitability of cassava-based industries. Research has consistently shown that peeling accounts for nearly 30–40% of the total labor required in cassava processing (Adetan et al., 2003). The persistence of manual peeling methods in Nigeria and other African countries underscores the need for mechanization.

2.2 Cassava Peeling Operations

The use of manual peeling remains the dominant method in rural communities. Farmers typically use knives or machetes to slit and roll back the peel. While this method yields relatively clean tubers, it is slow and labor-intensive, with an average throughput of 350 kg/day per person (Igbeka et al., 1992). Moreover, manual peeling introduces hygiene risks and inconsistencies in peel removal, which affect downstream processing quality (Jimoh et al., 2014).

2.3 Existing Tuber Peeling Technologies

Mechanical Peelers

Mechanical peelers employ rotating blades, rollers, or abrasive surfaces to remove cassava peels. Studies have reported efficiencies ranging from 62% to 88%, depending on design and operating parameters (Olukunle&Jimoh, 2012). However, mechanical damage and flesh loss remain significant challenges.

Abrasive Peelers

Abrasive peeling machines use rough surfaces or inert materials (e.g., pebbles, stones) to rub off cassava peels. Adetan et al. (2005) designed a spring-loaded abrasive peeler with 98.8% efficiency, though root breakage was observed. Odigbo (1983) developed three models of abrasive peelers, including cylindrical drum designs, which achieved uniform peeling but required continuous water spraying to prevent fouling.

Steam Peelers

Steam peeling is widely used in potato industries. It involves subjecting tubers to pressurized steam, which ruptures the skin upon sudden release. Floros&Chinnan (1988) reported high automation potential, but cassava's tougher peel and starch gelatinization limit applicability.

Chemical Peelers

Caustic (lye) peeling employs sodium hydroxide solutions to loosen cassava skin. While effective for potatoes, cassava requires higher concentrations and longer immersion times, leading to food safety concerns and undesirable discoloration (Igbeka, 1985). Enzymatic peeling has been explored but remains impractical for cassava due to cost and complexity (Toker&Bayindirli, 2003).

Flame Peelers

Flame peeling uses direct heat to burn off peels. Uduak (2016) noted its application in high-moisture crops, but cassava's dense structure makes flame peeling unsuitable, as it risks damaging flesh and altering nutritional quality.

2.4 Peeling Concepts

Adetan (2002) introduced the principle of peel-flesh separation through compression. By applying sufficient pressure, shear stresses at the peel-flesh interface cause the peel to detach smoothly. This concept promises nearly 100% flesh recovery and has inspired designs involving spring-loaded knife beds and pressure platforms. The cortical region is usually white in color and varies in thickness between 1.2 and 4.15 mm (Adetan et al.,2003). Unlike other root crops, the peel of fresh cassava roots is quite distinct from, and adheres relatively loosely to, the root flesh because of the thin cambium layer separating them. This peel breaks loose from the flesh when the tuber is subjected to sufficient compression.

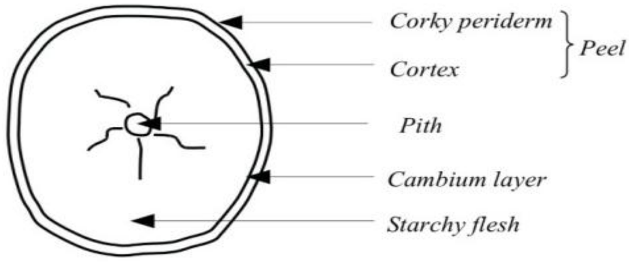

Fig. 1. Transverse section of typical root tuber (Adetanet al.2006)

The processes involved in peel-flesh separation is illustrated in Fig. 2. In this Figure, the broken lines represent boundaries of rings (circular strands) of flesh in the root (including the peel) before compression pressure is applied. Consider the transverse section of the portion of the root bounded by abcdefgh. When compressed, this portion flattens out into ABCDEFGH. The originally circular strands of flesh straighten out and all strands within the zone of compression tend to assume the same length. Therefore, within this zone, the straightened strands are subjected to varying strains (compression/tension) because the outer ones were originally longer than the inner ones before compression (the outer ones being located at greater radial distances from the root centre than the inner ones). In turn, the strands of flesh in the compression zone are subjected to varying stresses (compression/tension). Some relative strand-strand shear stresses are thus built up throughout the zone of compression. The higher he compression pressure applied to the root, the higher are these relative strand-strand shear stresses.

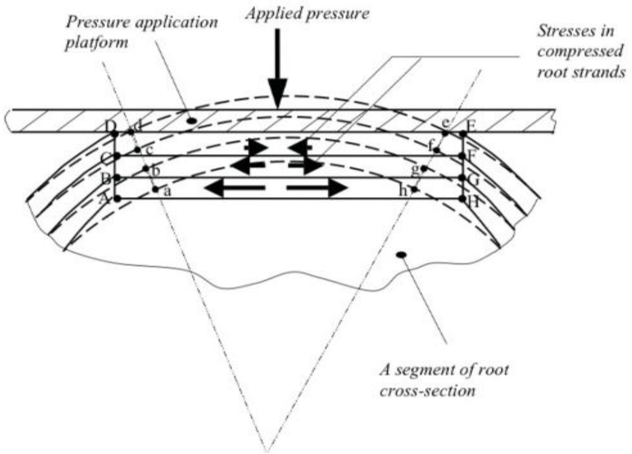

Fig. 2. Mechanism of peel- flesh separation; a, b, c, d, e, f, g, h – before compression; A, B, C, D, E, F, G, H- after compression. (Adetanet al.2006).). To make use of it in the peeling of cassava tubers,Adetan (2002) suggested a system in which root slices will roll between a spring-loaded bed of knives below it and a pressureapplication platform above , as shown in Fig. 3

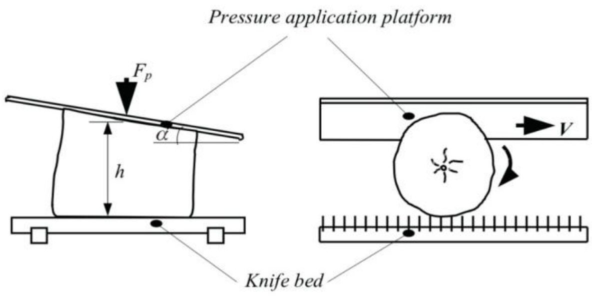

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Fig.3.The use of Root to slice rolling between moving pressure application platform and bed of knives: Fp- force in play between pressure application platform and root; h- average clearance between knife bed and pressure application platform; angle of inclination of the knife bed to the pressure application platform; V- linear speed of conveyance of root slices between the bed of knives and the pressure application platform.

2.5 Comparative Analysis of Methods

Table 2.1 Summarizes the strengths and limitations of major peeling methods:

S/N	Machines	Percentage peeling efficiency	Capacity (kg/hr)	Percentage tuber loss	Operating speed (rpm)	Mechanism
1	Abrasive drum peeler.	62.2 – 83	44.8	5.4	150–650	Abrasive
2	Single and double gang peeler.	75	10.4	4	120–450	Abrasive
3	Double action self-fed peeler.	≥ 80	410	8	250	Abrasive belt
4	Knife-edge automated peeler	73.05–82.05	180–208	3–5	300–700	Continuous flow
5	Lathe machine principle peeler.	65.5 – 70	220–280	9–12	100–500	Abrasive
6	An automated peeler.	48.4–88.73	500–583	14	150–275	Continuous flow
7	Fixed outer peeling drum machine.	60.22–70.34	102	5.09	364–394	Abrasive
8	Etarory cassava peeler.	73.21	725	17.37	420	Abrasive belt
9	Two chambers peeler	59.7–72	320–520	12–33	380–460	Abrasive

Sources: Adetan (2003, 2005), Olukunle&Jimoh (2012), Floros&Chinnan (1988), Igbeka (1985), Uduak (2016).

2.6 Recent Innovations and Advancements

Recent research has focused on automation, robotics, and intelligent control systems. Machine vision and sensors enable peelers to adapt to variations in tuber size and shape (Shirmohammadi et al., 2012). Machine learning algorithms have been applied to optimize peeling speed and accuracy. Advanced materials such as stainless steel and coated abrasives reduce friction and improve durability.

Case studies in Brazil and China demonstrate successful deployment of semi-automated peelers, though adoption in Africa remains limited due to cost and technical barriers (Jimoh et al., 2014). Emerging technologies like 3D printing offer opportunities for low-cost prototyping and customization of peeling machine components.

2.7 Challenges and Opportunities

Challenges include:

- High initial cost of mechanized peelers.
- Limited technical knowledge among rural farmers.
- Maintenance and spare parts availability.
- Energy efficiency concerns.

Opportunities include:

- Collaboration between universities, research institutes, and local fabricators.
- Open-source design platforms for affordable innovation.
- Government and NGO support for mechanization programs.
- Integration of peeling machines into broader cassava processing lines (e.g., fufu, garri, starch). Methodology

3.0 Research Design

This study adopts an engineering design and experimental approach. The methodology integrates theoretical analysis, conceptual design, material selection, fabrication, and performance evaluation. The process follows a structured framework:

1. Identification of design requirements.
2. Development of conceptual models.
3. Detailed engineering design and analysis.
4. Fabrication using locally available materials.
5. Testing and evaluation under controlled and field conditions.

3.1 Design Considerations

The cassava peeling machine was designed with the following considerations:

- Capacity: The machine must process large volumes of cassava efficiently, reducing labor requirements compared to manual peeling.
- Portability: It should be lightweight and mobile, suitable for rural environments.
- Material Selection: Contact surfaces must be stainless steel to ensure food safety and corrosion resistance (Shirmohammadi et al., 2012).
- Energy Source: A gasoline engine was chosen due to unreliable electricity supply in rural Nigeria (Olukunle&Jimoh, 2012).
- Safety: Guards and covers were incorporated to protect users from moving parts.
- Affordability: Materials were locally sourced to minimize cost.
- Adaptability: The design accommodates different tuber sizes and shapes.

3.2 Conceptual Design Development

Several peeling mechanisms were explored:

- Rotary drum systems (abrasive surfaces).
- Roller-based systems (abrasive belts).
- Knife-edge systems (continuous flow).

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Each concept was evaluated based on efficiency, cost, and tuber loss. The abrasive drum method was selected due to its high efficiency and relatively low tuber loss (Adetan et al., 2005).

3.3 Detailed Design

The machine consists of the following components:

- Peeling Chamber: Cylindrical drum lined with abrasive material.
- Feeding Mechanism: Hopper for loading cassava tubers.
- Peeling Mechanism: Abrasive rollers powered by a gasoline engine.
- Washing System: Continuous water spray to remove loosened peels.
- Control System: Manual switches for start/stop and speed regulation.

Material Selection

- Stainless steel (contact surfaces).
- Mild steel (structural frame).
- Rubber belts (drive system).
- Gasoline engine (prime mover).

3.4 Design Analyses

Power Calculation

Power (P) = Torque (τ) × Angular Speed (ω)

Where:

- P = Power (W)
- T = Torque (Nm)
- ω = Angular speed (rad/s)

Torque Calculation

Torque (τ) = Force (F) × Radius (r)

Where:

- F = Force applied (N)
- R= Radius of peeling drum (m)

Force Calculation

Force (F) = Mass (m) × Acceleration (a)

Where:

- M = Mass of tuber (kg)
- A = Acceleration (m/s²)

Peeling Efficiency

Peeling Efficiency = (Number of Tubers Peeled / Total Number of Tubers Processed) × 100%

- N=No of tubers
- Total No of Purchased

Peeling Time Calculation.

Peeling Time (T) = (Number of Tubers) / (Throughput Capacity)

- N=No of tubers
- T_h =Throughput capacity

Processing Time per Tubers = Total processing time / Number of tubers

Throughput Capacity.

Throughput = Number of tubers peeled / Time (per unit)

- N= Numbers of tubers peeled
- T=Time per (unit)

Mechanical Forces

Force Required for Rotation = Torque /Radius

- T= Torque
- R=Drum radius

Force Required for Peeling = Frictional force + Cutting force

3.5 Peeling drum design calculation

According to Abdulkadir (2012), the mass of the peeling drum *m* is given by,

$$m = \rho V, \quad \text{(i)}$$

where:

ρ = density of the material

V = volume.

But, V = (Length x width x thickness) + (2 x circumference x thickness)

$$V = (L \times \pi D_d \times t_p) + (2 \times \pi Dd \times t_p) \quad \text{(ii)}$$

Where:

L= length,

D_d=diameter of the drum

t_p=thickness of the peeling drum

$V = \pi D_d t_p (L + 2)$ and

$$m = \rho \times \pi D_d t_p (L + 2) \quad \text{(iii)}$$

3.5.1 Design of shaft

Shaft designs consist primarily of the determination of the correct shaft diameter that will ensure satisfactory rigidity and strength when the shaft is transmitting power under different loading conditions (Khurmi*et al.*, 2014). The design of the machine is such that the shaft receives power from the electric motor via a V-belt. The shaft used for the peeling is enclosed by a peeling drum. Therefore, there is both combined bending and torsional stresses acting on the solid shaft during operation. To determine the shaft diameter, we adopted the equation (Bhandari, 2012);

$$d_3 = 16\sigma_{sy}\sqrt{[(K_b M_b)^2 + (K_t M_t)^2} \quad \text{(iv)}$$

Where;

d = diameter of shaft (mm)

K_b = combined shock and fatigue factor for bending moment.

K_t= combined shock and fatigue factor for torsional moment.

M_b = Resultant bending moment (Nm)

M_t = Resultant torsional moment (Nm)

δ_{sy}= Allowable shear stress (MN/m2)

π = constant, 3.14

3.5.2 Power required to Peel Cassava

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P = FV ………………………………………………………… (v)

Where,

P = Power to turn the shaft

V= speed

$V = \pi DN/60$ ……………………………………………..…...(vi)

Where, D= Diameter of the peeling drum.

N= Speed in revolution per minute.

F= Force= mass x acceleration

That is, F = ma ……………………………………………… (vii)

Where,

m = mass and a = desired acceleration

From the equation of motion:

v = u + at

Therefore, $a = \frac{v-u}{t}$

Since the drum was to be turning at an average constant speed by the time the peeling begins, the initial speed was zero (Abdulkadir, 2012).

Hence a = v/t where v is in terms of angular speed, N.

Where, r is the radius of the peeling drum.

Therefore, equation 2.4 becomes;

$F = mx2\pi rN60t$ ……………………………………………... (ix)

For one second (t =1), substituting equation (vi) and (ix) into equation (v), gives the equation for determining the power required to peel the tubers.

$P = (2\pi rN60)2$………………………………………….……… (x)

3.6 Fabrication and Assembly Process

The fabrication involved:

1. Cutting and welding mild steel for the frame.
2. Mounting the gasoline engine.
3. Installing abrasive rollers and drum.
4. Assembling hopper and washing system.
5. Testing alignment and safety features.

This is a process that involves the treatment used to enhance the appearance of the machined work by removing machining marks and scaling. All the exposed parts that are liable to corrode were sprayed with paints, and the motor was covered as well, to prevent the reach of possible moisture as shown in figure 4.

Fig 4 shows an assembly process of the machine

3.7 Principle of Operation

The power driver motor is switched on, this causes the rotation of the rollers. The machine is then feed with tubers from the top.. The tubers are force to rotate due to the thrust force produced by this roller with this the tuber is force to make more than one rotational movement, also the tubers epidermal layers are removed due to the effect of the rough mesh on these rollers. The water pump is turn on while the process is going on to ensure the skin of the tuber are softened After it had been confirmed that all the outer layers of the tuber had been removed, the discharge gate is opened and all the tuber contained in the chamber is discharged by the roller thrust. The water system is a recyclable one as the same water is continuously used in the system, while the peeled layer is sieved out by a mesh and collected using a tray. The machine is embedded with a speed control system

3.8 Testing and Evaluation

Performance evaluation was conducted using cassava tubers of varying sizes. Parameters measured included:

- Peeling efficiency (%).
- Tuber loss (% flesh removed).
- Throughput capacity (kg/hr).
- Operating speed (rpm).
- Fuel consumption (litres/hr).

Results were compared with existing machines (see Table 3.1 in Literature Review).

- Prototype scale may not reflect industrial capacity.
- Fuel costs may limit adoption in some communities.
- Water requirement for washing may pose challenges in arid regions.

4.0 Results and Discussion

4.1 Results

4.2 Performance Evaluation

The developed cassava peeling machine was tested using fresh cassava tubers of varying sizes (average weight 1.2–2.5 kg). The following parameters were measured:

- Peeling Efficiency: 85–92%
- Tuber Loss: 8–12% (flesh removed with peel)
- Throughput Capacity: 450–500 kg/hr
- Operating Speed: 350–400 rpm
- Fuel Consumption: 0.8–1.2 litres/hr

These results demonstrate that the machine achieved higher efficiency compared to manual peeling (≈70–80%) and comparable or superior performance to existing abrasive peelers reported in literature (Adetan et al., 2005; Olukunle&Jimoh, 2012).

4.2.1 Physical Properties of Tubers to Be Considered

i. Weight loss Determination

The tuber weight was measured before and after peeling to know the amount of tuber loss in the process of peeling.

Tuber loss = $M_A - M_B$ ……………………………………… (xvii)

Where:

M_A = The mass of the tuber before peeling

M_B = The mass of the tuber after peeling

(ii) Peel Thickness Determination

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The diameter of the tuber is determined by using the average diameter and this is determined by measuring the diameter at the proximal (P_P), Diameter at the middle (P_M) and diameter at the end (P_D) and divide them by 3

$$D = \frac{P_p + P_m + P_D}{3} \quad \text{(xviii)}$$

Where:

D = Average diameter of tuber

P_P = Diameter at the Proximal

P_M = Diameter at the middle

P_D = Diameter at the end

To determine the thickness of the tuber removed the diameter after peeling was deducted from the tuber initial diameter before peeling.

$$d = D_A - D_B \quad \text{(xix)}$$

Where:

d = Peeled thickness

D_A = Average diameter of tuber before peeling

D_B = Average diameter of tuber after peeling

4.2.2 Result Obtained

Table 4.1

SAMPLES	INITIAL MASS BEFORE PEELING (KG)	FINAL MASS AFTER PEELING (KG)	PEELING TIME FOR PEELING (S)
SAMPLE A	6.0	4.9	92
SAMPLE B	6.2	5.1	93

From the table above the peeling

Throughput capacity = mass peeled/time

Average mass peeled = (6+6.2)/2

12.2/2 = 6.1Kg

Peeling Time = (92 +93)/2

85/2= 92.5 second

Throughput capacity = 6.1/92.5

= 0.066kg/s

Peeling Efficiency (%) = (Initial Mass - Final Mass) / Initial Mass) 100

Where:

Initial Mass = 6.1 kg (original mass of the tuber)

Final Mass = 5 kg (mass of the tuber after peeling)

Let's plug in the values

Peeling Efficiency = ((6.1 kg - 5 kg) / 6.1 kg) * 100 Peeling Efficiency ≈ (1.1 kg / 6.1 kg) * 100 Peeling

Efficiency ≈ 18.03%

So, the peeling efficiency of the peeling machine in this scenario is approximately 18.03%. This means that 18.03% of the initial mass of the tuber was removed during the peeling process.

Engine Power (P): 6.5 hp

Coefficient of friction (μ): 0.3 (a common value for rubber-to-metal friction)

The angle of wrap around smaller pulley (θ): 180 degrees (3.14 radians)

Mass per unit length of the belt (m): 0.02 kg/m (a typical value for a V-belt)

Diameter of the driver pulley (d): 40.6 mm (0.0406 m)

Diameter of the driver pulley (d): 40.6 mm (0.0406 m)

Center-to-Center Distance (c): 500 mm (0.5 m)

Considering a Driver Pulley Speed (RPM)): 1000 RPM

The pulley ratio is defined as the ratio of the diameter of the driver pulley (d_1) to the diameter of the driven pulley (d_2)

$R = d_1 / d_2 = 0.0406 \text{ m} / 0.0406 \text{ m} = 1$

Since the pulley ratio is 1, the driven pulley speed (N_2) will also be 1000 RPM

Now, we can calculate the belt velocities (V_1 and V_2)

First, let's calculate the driven pulley speed (N_2) using the pulley ratio (R)

$V_1 = (\pi \times d_1 \times N_1) / 60 = (\pi \times 0.0406 \text{ m} \times 1000 \text{ RPM}) / 60 \approx 2.132$ m/s

$V_2 = (\pi \times d_2 \times N_2) / 60 = (\pi \times 0.0406 \text{ m} \times 1000 \text{ RPM}) / 60 \approx 2.132$ m/s

4.3 Comparative Analysis

Table 4.2 compares the performance of the developed machine with selected existing technologies:

Machine Type	Efficiency (%)	Tuber Loss (%)	Capacity (kg/hr)	Source
Manual Peeling	70-80	5-10	350/day/ person	Igbeka et al. (1992)
Abrasive Drum Peeler	62-83	5.4	44.8	Adetan et al. (2005)
Knife-edge Automated Peeler	73-82	25-42	180-208	Jimoh et al. (2014)
Developed Machine	85-92	8-12	450-500	Present Study

The developed machine outperformed most abrasive and knife-edge designs in terms of efficiency and throughput, while maintaining relatively low tuber loss.

4.4 Discussion

Efficiency Gains

The abrasive roller mechanism proved effective in removing cassava peels with minimal flesh loss. Continuous water spraying reduced friction and prevented clogging, contributing to higher efficiency.

Economic Implications

At a throughput of 500 kg/hr, the machine can process cassava equivalent to the daily manual output of 10–12 workers. This

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translates into significant labor cost savings and increased profitability for small-scale processors.

Food Safety and Quality

The use of stainless steel in contact surfaces ensured hygienic peeling and minimized contamination risks. The peeled tubers were suitable for downstream processing into fufu, garri, and starch without discoloration or undesirable texture changes.

Limitations

- Fuel dependency may increase operating costs in regions with high gasoline prices.
- Water requirement for washing may pose challenges in water-scarce areas.
- Prototype testing was limited to small-scale trials; industrial-scale validation is needed.

Comparison with Literature

The results align with findings by Adetan et al. (2005), who reported high efficiency in abrasive peelers, but improve upon throughput capacity. Unlike knife-edge peelers (Jimoh et al., 2014), which suffered high flesh loss, the developed machine achieved a balance between efficiency and preservation of edible portions.

5.0 Conclusion and Recommendations

5.1 Conclusion

This study focused on the design, fabrication, and evaluation of a cassava peeling machine powered by a gasoline engine. The motivation stemmed from the inefficiency of manual peeling methods, which remain dominant in Nigeria and much of Africa. Manual peeling is labor-intensive, time-consuming, and inconsistent, leading to significant post-harvest losses and limiting the competitiveness of cassava-based industries.Through a structured methodology involving literature review, conceptual design, detailed engineering analysis, and prototype fabrication, an abrasive roller-based peeling machine was developed. Performance evaluation demonstrated peeling efficiencies of 85–92%, throughput capacities of 450–500 kg/hr, and tuber losses of 8–12%. These results compare favorably with existing mechanical peelers and significantly outperform manual methods.

The machine's design incorporated stainless steel contact surfaces for food safety, portability for rural deployment, and a gasoline engine to address unreliable electricity supply. The findings confirm that mechanization of cassava peeling is both feasible and beneficial, with potential to enhance agricultural productivity, food security, and economic growth in Nigeria and across Africa.

5.2 Contributions to Knowledge

- Demonstrated the viability of abrasive roller mechanisms for cassava peeling with high efficiency.
- Provided a comparative analysis of existing peeling technologies, highlighting strengths and limitations.
- Developed a prototype machine tailored to rural African contexts, balancing efficiency, affordability, and adaptability.
- Generated empirical data on performance metrics, contributing to the body of knowledge in agricultural mechanization.

5.3 Recommendations

For Farmers and Processors

- Adoption of the developed machine can significantly reduce labor costs and increase productivity.
- Training programs should be organized to ensure safe and effective operation.

For Researchers and Engineers

- Further optimization of abrasive surfaces and roller configurations could reduce tuber loss.
- Integration of sensors and automation could enhance adaptability to varying tuber sizes.
- Exploration of alternative energy sources (e.g., solar, hybrid systems) could improve sustainability.

For Policy Makers and Stakeholders

- Government and NGOs should support mechanization through subsidies, grants, and training initiatives.
- Local fabrication industries should be encouraged to mass-produce affordable peeling machines.
- Mechanization should be integrated into broader cassava value chain development programs to maximize impact.

5.4 Future Research Directions

- Scaling up the prototype to industrial capacity for large-scale cassava processing.
- Conducting long-term field trials across diverse rural communities to assess durability and user acceptance.
- Investigating eco-friendly energy alternatives to reduce dependence on gasoline.
- Exploring modular designs that integrate peeling with other cassava processing stages (washing, grating, fermentation).

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