AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT (AAMUSTED).

DEPARTMENT OF MECHANICAL ENGINEERING TECHNOLOGY

DESIGN AND FABRICATION OF A MINI MOTORIZED CASSAVA GRATING MACHINE

BY

N-EKABONG VITALIS BONIFACE

OCTOBER, 2023

AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT (AAMUSTED)

DEPARTMENT OF MECHANICAL ENGINEERING TECHNOLOGY

DESIGN AND FABRICATION OF A MINI MOTORIZED CASSAVA GRATING MACHINE

BY

N-EKABONG VITALIS BONIFACE-(7211220004)

A PROJECT REPORT PRESENTED TO THE DEPARTMENT OF MECHANICAL ENGINEERING TECHNOLOGY AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT, KUMASI IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER IN MECHANICAL ENGINEERING TECHNOLOGY.

OCTOBER, 2023

DECLARATION

STUDENT'S DECLARATION

I, **N-EKABONG VITALIS BONIFACE,** declare that this project work is my original work. I have conducted the necessary research and completed this project to the best of my abilities.

I affirm that all sources used in this project have appropriately acknowledged and cited. I take full responsibility for the accuracy and integrity of the information presented.

This project work has not been submitted for any other academic or professional purpose. I understand the importance of academic honesty and affirm my commitment to upholding the highest standards of integrity

SIGNATURE………………………………….. **DATE.**21/02/2024

N-EKABONG VITALIS BONIFACE

SUPERVISOR'S DECLARATION

I, **DR. GYIMAH K. OFFEH,** hereby declare that I have supervised this project work titled **'DESIGN AND FABRICATION OF A MINI MOTORIZED CASSAVA GRATING MACHINE'** conducted by **N-EKABONG VITALIS BONIFACE.**

I confirm that I have provided guidance and oversight responsibilities throughout the project's duration, and I am satisfied with the student's efforts and outcomes.

SIGNATURE ………………………………… **DATE.**21/02/2024

DR. GYIMAH K. OFFEH

DEDICATION

This project is dedicated to all those who have supported and believed in its success. Your encouragement and contributions have been invaluable throughout the journey.

Thank you for your unwavering support.

ACKNOWLEDGMENTS

I would like to acknowledge and express my gratitude to the individuals and organizations that supported and contributed to the completion of this study on the Design and fabrication of a mini motorized cassava grating machine.

First and foremost, I extend my sincere appreciation to God and to my supervisor Dr. Gyimah K. Offeh and my research advisors for their invaluable guidance, expertise, and continuous support throughout the research process. Their insights and advice were instrumental in shaping the direction of this study.

I would also like to thank the participants who willingly provided their time and cooperation for the manufacturing and assembling of the project. Their contribution was essential in obtaining the necessary data, materials and ensuring the reliability of the study's findings.

Furthermore, I extend my appreciation to the Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development (AAMUSTED) for providing the necessary resources, facilities, and equipment for the manufacturing processes. The support was crucial in ensuring the smooth progress of the research.

I am grateful to my colleagues and fellow researchers who provided valuable feedback, suggestions, and assistance throughout the study. Their collaboration and intellectual contributions significantly enriched the quality of this project.

Finally, I would like to express my gratitude to all the authors, researchers, and institutions whose works and publications were referenced in this study. Their prior contributions laid the foundation for my research and provided valuable insights into the field of design and fabrication of motorized cassava grating machines.

I acknowledge the collective efforts of all those involved in this study, as their contributions played a vital role in its successful completion

TABLE OF CONTENTS

CONTENT PAGES

TABLE OF CONTENT

TABLES **PAGES**

LIST OF FIGURES

FIGURES **PAGES**

ABSTRACT

This study intends to address the limitations of traditional and manual cassava grating methods by developing and testing a motorized cassava grating machine with a self-feeding feature. The aim is to reduce the reliance on human involvement in the grating process. Ensuring a high level of hygiene compared to the traditional hand method and existing manual machines. The manufactured motorized cassava grating machine will be suitable for use for domestic and small scale cassava grating production, this will increase the level of production and improve the hygiene level of the products.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Cassava (Manihot Esculenta Crantz) originated from Brazil and is now found in the tropical areas of Africa, the Far East, and the Caribbean Islands through the Portuguese during the 16th and 17th centuries (Jones, 1959). The root crop is capable of yielding 48.7Mt per hectare under rain-fed conditions (P. A. Asare1, I. K. A. Galyuon2, E. Asare-Bediako1,2014). Cassava tubas May considerably vary in size from 15 to 100 cm as well as in terms of weight from 0.5 to 2.0 kg (Westby, 2009).

Cassava contributes significantly (22%) to the Agricultural Gross Domestic Product (AGDP) (Nweke, 2005). It is very rich in starch and contains significant amounts of calcium (50 mg/100g), phosphorus (40 mg/100g), vitamin C (25 mg/100g), and relatively good quality protein (Kolawole, Agbetoye, & Ogunlowo, 2010). Gari, Tapioca (starch), and Agbelima (fermented cassava mash) are among other numerous staple foods in Africa, especially in Ghana and Nigeria that are products of cassava (Kleih, Phillips, Wordey, & Komlaga, 2013). The vast economic and health benefits of cassava led to a steady increase in its production in Ghana. From the year 2000 to 2010, the annual production in Ghana increased progressively from 8,107,000Mt to 13,504,000Mt. The increasing production level of the commodity makes it necessary to mechanize its processing. The stages in cassava processing include either one or more of the following; peeling, washing, grating or chipping, pressing (de-watering), pulverization, sieving, roasting, and milling, depending on the type of end product required (Richard Bayitse, Ferdinand Tornyie, 2019).

1.2 Statement of the Problem

Foods like Gari and Agbelema require the grating of cassava in the processing step. This grating process has been performed by the local people for centuries and continues to be practiced. Inventions have introduced manual grating machines but the needs of more human effort and increase human labor in rural areas has made it significant that more reliable powered grating machine be made available to the graters. For this reason, the project has been conceived and a motorized cassava grating machine will be manufactured.

1.3 Significance of the Study

The reason behind this study was, therefore, to address the limitations of traditional and manual cassava grating methods by developing and testing a motorized cassava grating machine with a self-feeding feature. The aim is to reduce the reliance on human involvement in the grating process, ensuring a higher level of hygiene compared to the traditional hand method and existing manual machines.

By constructing the grater with indigenous materials, the machine will be suitable for local conditions, taking into account factors such as durability, affordability, and accessibility. The utilization of local materials promotes sustainability and facilitates maintenance and repairs within the local context.

To ensure the desired quality of cassava mash, the grating plate employed in the machine will be designed to achieve a very fine grating texture. This will enable the production of consistent and uniform cassava mash, contributing to the improvement of downstream cassava processing and product quality.

The developed motorized cassava grating machine aims to enhance efficiency, productivity, and hygienic standards in cassava processing, ultimately benefiting local cassava farmers, processors, and consumers alike.

1.4 Aim and specific objectives

1.4.1 Main objective

The main aim of the project is to manufacture a motorized cassava grating machine.

1.4.2 Specific objectives

1. To design a motorized cassava grating machine
2. To fabricate the motorized cassava grating machine with electrical energy as its source
3. To test the machine's grating capacity and efficiency in comparison to the traditional hand method.

1.5 Scope of Study

This project is aimed at designing, constructing, and testing motorized cassava grating machines in comparison with traditional hand grating. It will be suitable for use for domestic and small-scale cassava grating production in Ghana and any part of the world with similar conditions, for household as well as industrial use.

1.6 Limitation

The efficiency of the developed motorized cassava grating machine will be compared to the traditional hand grating only due to scarcity of funds. However, there could be useful findings if they were compared to other forms of graters and even the solar powered graters.

One major limitation of motorized cassava grating machines is their dependence on a continuous and reliable power supply. These machines require electricity or fuel to power the motor that drives the grating mechanism. In many regions, particularly in rural or underdeveloped areas, the availability of consistent and affordable electricity can be a challenge. Power outages or limited access to electricity can significantly hinder the operation of motorized cassava grating machines, making them less practical and reliable in such settings.

1.7 Organization of research

The research work on the cassava grating machine consists of five (5) chapters that systematically delve into different aspects of the project.

Chapter One (1) serves as the introduction, providing the background of the studies and shedding light on the significance of the research. It also outlines the specific aim and objectives of the project and sets the scope of the study.

In Chapter Two (2), the literature review presents a comprehensive analysis of existing cassava grating machines, traditional processing techniques, and recent technological advancements in the field. This section provides a strong foundation for the subsequent chapters.

Moving on to Chapter Three (3), the conceptual design phase takes center stage, where design requirements are established, and various ideas are generated and evaluated to arrive at the final design concept.

In Chapter Four (4), the focus shifts to the fabrication and assembly of the cassava grating machine. The materials, components, and the step-by-step fabrication process are described, along with testing procedures to ensure the machine's functionality and performance.

Finally, Chapter Five (5) concludes the research work, summarizing the entire project and its findings, highlighting the implications, and offering recommendations for further improvement. This organized structure ensures a comprehensive and insightful exploration of the motorized cassava grating machine project from inception to completion.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The purpose of this study is to focus on the development of a motorized cassava grating machine. Grating cassava into mash is a critical processing step following peeling since a majority of cassava products are derived from grated cassava. The successful mechanization of this step is crucial for enhancing cassava processing efficiency, as it can significantly impact productivity and product quality. Therefore, the development of an efficient and reliable motorized cassava grating machine is essential.

Cassava processing involves a series of steps, and grating cassava holds a central position in the overall process. The quality of the grated cassava directly affects the final products and their market value. Traditional methods of grating cassava are predominantly manual, which poses several challenges such as labor intensiveness, low throughput, and inconsistent product quality. These challenges necessitate the development of mechanized alternatives to improve processing efficiency.

In recent years, there have been notable efforts to develop cassava grating machines that aim to address the limitations of traditional methods. Previous research and developments in this field have led to the introduction of various prototypes and commercial machines designed specifically for cassava grating. These machines employ different principles and mechanisms to achieve efficient grating, aiming to improve processing capacity and reduce labor requirements.

This chapter provides a comprehensive review of the steps involved in cassava processing, with a specific focus on the grating process. It explores the traditional methods of grating cassava and discusses their drawbacks in terms of efficiency and product quality. Additionally, this chapter examines the types of cassava grating machines currently in use within the industry. By understanding the existing machines, their features, advantages, and limitations, it becomes possible to identify areas for improvement and innovation in the design of a motorized cassava grating machine.

The literature review serves as the foundation for developing a motorized cassava grating machine that meets the requirements of the industry. By examining previous research and existing machines, this study aims to contribute to the advancement of cassava processing technology by developing an efficient, cost-effective, and user-friendly motorized cassava grating machine.

2.2 Cassava processing steps

The most common steps used in processing cassava into desired products typically involve peeling and washing, grating or chipping, and then dewatering or pressing (Richard Bayitse, Ferdinand Tornyie, 2019). These steps are crucial in transforming fresh cassava into various cassava-based products.

After harvesting fresh cassava from the farm, the outer layer, which is usually brown, is removed using simple knives or machetes (Figure 2.1). The removed peelings can be utilized as by-products for animal feed. The peeled cassava is then washed and cut into smaller units in preparation for the next processing steps, such as grating or chipping.

The specific processing steps depend on the intended final product. For example, if the desired product is gari, the cassava is grated into a fine mash, followed by dewatering or pressing. The resulting mash is then allowed to ferment for approximately 2 to 3 days, sifted to crush any lumps caused by pressing, and finally roasted or fried to produce gari.

In the case of agblema production, the cassava is also grated into a fine mash. After the grating process, the mash is allowed to ferment for approximately 2 to 3 days, sieved to remove any impurities, and then boiled in banana leaves to create agblema.

For flour production, the cassava is chipped into smaller pieces, which facilitates faster drying. The chipped cassava is then dried and milled into flour, which can be used in various culinary applications.

These processing steps demonstrate the importance of grating or chipping cassava in the overall cassava processing chain. Successful mechanization of this step, as emphasized by Bayitse and Tornyie (2019), is key to improving cassava processing efficiency.

Figure 2.1: **Peeling of cassava by women at Bawjoase in the Central Region, Ghana**

2.3 Advantages and Disadvantages of the cassava processing steps

1. Peeling and Washing:

Advantages:

- Removes the outer layer of the cassava, reducing the chances of contamination and improving the product's quality.
- Washing helps in further eliminating dirt and impurities, ensuring a clean and hygienic product.
- Peels can be used as by-products for animal feed, reducing waste.

Disadvantages:

- Manual peeling can be time-consuming and labor-intensive, especially for large-scale processing.
- There is a risk of injuries during peeling if proper tools and safety measures are not used.

1. Grating or Chipping:

Advantages:

- Grating or chipping breaks down the cassava into smaller pieces, increasing the surface area for subsequent processing steps.
- It helps in preparing the cassava for further dewatering, pressing, or fermentation, depending on the intended product.

Disadvantages:

- Grating can be a physically demanding task, particularly for large quantities of cassava.
- Inadequate grating may result in uneven processing, affecting the overall quality of the final product.

2. Dewatering or Pressing (for Gari production):

Advantages:

a. Removes excess moisture from the grated cassava, promoting efficient fermentation and preventing spoilage.
b. Pressing enhances the extraction of water, leading to a drier and more shelf-stable product.

Disadvantages:

a. Pressing might require specialized equipment, which can be costly for small-scale producers.
b. Over-pressing can lead to an excessively dry mash, affecting the texture and taste of the final product.

3. Fermentation (for Gari and Agblema production):

Advantages:

a. Fermentation improves the flavor, aroma, and digestibility of the cassava-based products.
b. It allows for the breakdown of certain toxic compounds present in raw cassava.

Disadvantages:

a. Fermentation requires precise timing and environmental conditions. Improper fermentation can lead to off-flavors or spoilage.
b. Longer fermentation periods can increase production time, affecting overall productivity.

4. Roasting or Frying (for Gari production) / Boiling (for Agblema production) / Milling (for Flour production):

Advantages:

a. Roasting or frying (for Gari) imparts a desirable flavor and texture to the final product.

b. Boiling (for Agblema) helps in setting the product's shape and consistency.

c. Milling (for Flour) produces a fine, uniform flour suitable for various culinary uses.

Disadvantages:

a. Roasting or frying requires careful monitoring to prevent burning or uneven cooking (for Gari).

b. Boiling can lead to loss of certain nutrients and flavors (for Agblema).

c. Milling requires specialized equipment, which may not be readily available in some regions (for Flour).

Overall, these processing steps offer various benefits but also come with their own set of challenges, particularly regarding manual labor, equipment requirements, and quality control. Proper handling and optimization of each step are crucial to achieving high-quality cassava products efficiently.

2.4 Traditional methods of Grating Cassava

In the old days, mortar and pestle were the tools used for producing cassava mash. The pounding was the only available method of processing peeled cassava into the desired grade of cassava mash until artisans, later on, developed the hand grater. This consists of a thin metal sheet perforated with about 3mm diameter nail to produce sharp projections on one surface. The plate is then nailed to a piece of wood with the rough surface outwards. During grating, peeled cassava tuber is rubbed against the rough plate surface by hand to produce cassava mash (George, 2018). This gives better results than pounding, especially when granules are required. However, it is steel fatiguing and risky since the hand of the user could be injured by the grating plate when the cassava tuber reduces to a smaller piece (Opandoh, 2015).

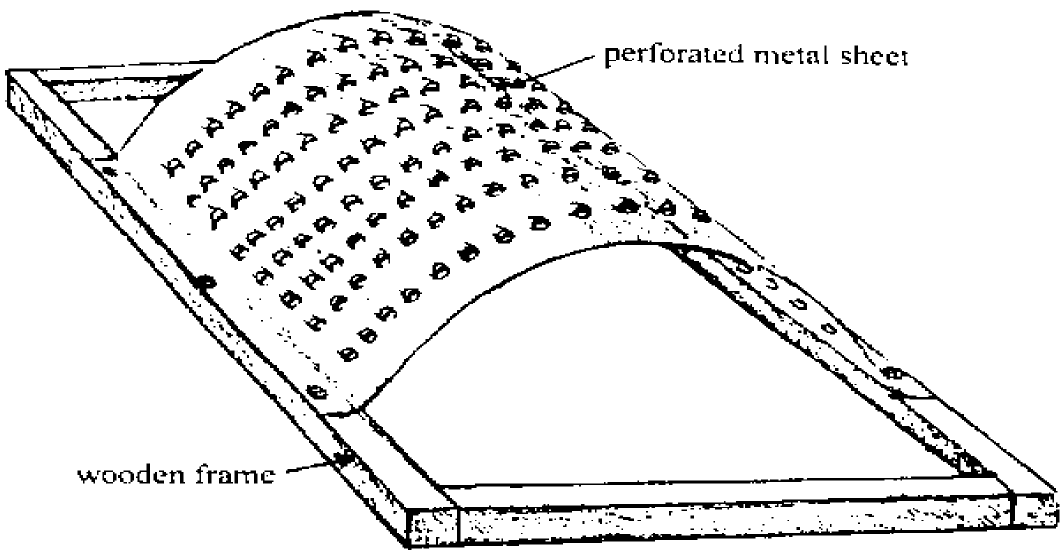


Figure 2.2: A Hand Grater (Opandoh, 2015)

Table 1. Advantages and Disadvantages of Hand Grater (Adetunji, O. R., & Quadri, A. H. 2011)

Advantages of Hand Grater	**Disadvantage of Hand Grater**
Simple and Low-Cost	Labor-Intensive
Easily Accessible Tools and Equipment	Time-Consuming
Local Knowledge and Skills Utilization	Inconsistent Output
Minimal Environmental Impact	Lower Processing Efficiency

Preservation of Traditional Techniques	Limited Scale of Production

2.5 Manually operated cassava graters

Manually operated cassava graters are mechanical cassava graters with the source of the drive being their operators. They can be put into two groups namely; hand operated and pedal-operated cassava grating machines. In both cases, no engine or electric motor is used.

2.5.1 Hand-operated cassava grating machines

This is a category of manually operated cassava graters in which the grating drum is rotated through a crank turned by the operator's hand. Apodi et al., (2018) designed and manufactured a hand-operated cassava grater operated by two hands. Peeled and washed cassava is cut into smaller pieces and fed into the hopper. One hand uses a presser to force the cassava against the grating drum while the other hand turns the crank to rotate the grating drum. Its capacity was about 314 kg/h since it grated 78.5kg of cassava within 15 minutes. It recorded 5.5% waste with 94.5% efficiency. Figure 2.3 shows a picture of the constructed hand-operated manual cassava grater.

Figure 2.3: **The constructed hand-operated manual cassava grater (Apodi et al., 2018)**

Ndaliman, (2006) designed and constructed a portable hand-operated cassava grating machine. He however made provision for the use of an electric motor when the need arises. Its operation involves feeding peeled and washed cassava into the metal hopper and pressing the cassava against the rotating drum with a piece of wood. In this design, the grating drum is either rotated by a hand crank or an electric motor through a pulley and belt drive. The efficiency of the machine when operated manually was found to be 92.4%. it was tested with only 2.0 kg of cassava which is willfully inadequate to give a true picture of its grating capacity and efficiency. The grating capacity, a very important parameter, was however omitted. Figure 2.4 shows a picture of the constructed dual-operational mode cassava grating machine.

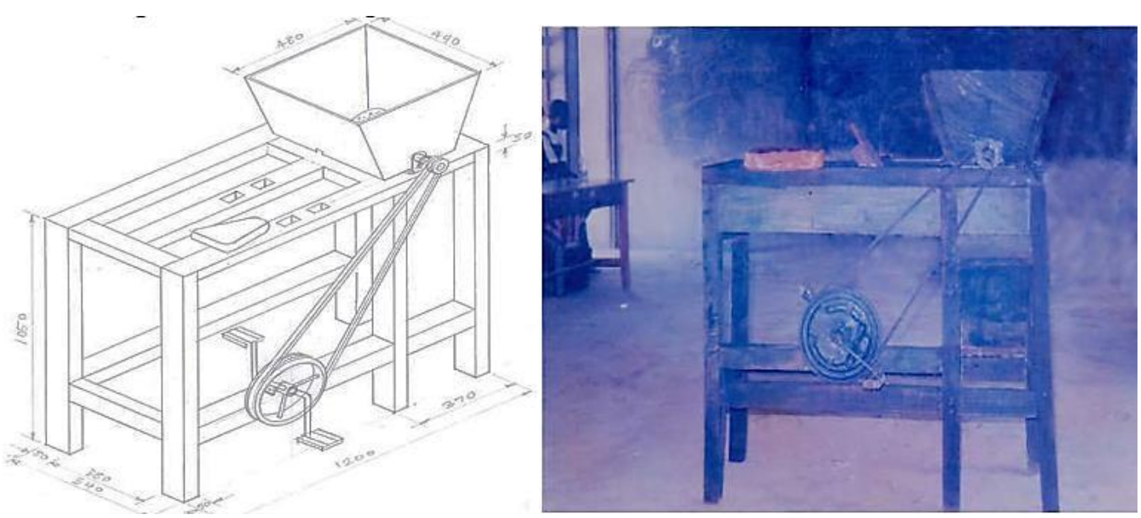
Figure 2.4: **A Dual - Operational Cassava Grating Machine (Ndaliman, 2006)**

Table 2. Advantages and Disadvantages of Manual Operated Cassava Grating Machine (Adetunji, O. R., & Quadri, A. H. 2011)

Advantages of Manual cassava Grating	**Disadvantages of Manual Cassava Graters**
Cost-effective	Labor-intensive
Simple and Potable	Inconsistent Output
Low Energy Consumption	Limited Production Capacity
Easy Maintenance	Potential Risks

2.4.2 Pedal-operated Cassava grating machines

This is a category of manually operated cassava graters in which the grating drum is rotated by a chain and sprocket driven through the foot pedaling of two cranks. Yusuf et al., (2019) designed and fabricated a pedal-operated cassava grating machine with a stand and hopper made of hardwood. Peeled cassava is washed, cut into smaller pieces, and fed into the wooden hopper. The operator then sits on a seat and pedals the pair of cranks that cause the rotation of the grating drum through the chain and sprocket drive. It had a grating capacity of 102.9 kg/h and an efficiency of 90.91%. Though the capacity and efficiency of this pedal-operated grater are lesser than that of the hand-operated grater by Apodi et al., (2018), the pedal operation is more comfortable than the hand operated. However, if pair of handles for the operator were included it would have made it more convenient to operate, which could lead to an increase in its grating capacity and efficiency. Figure 4 presents a picture of the pedal-operated cassava grater.



(a) (b)

Figure 2.5: Pedal-operated cassava grater (a) Isometric view (b) Picture after construction (Yusuf et al, 2019)

Table 3. Advantages and Disadvantages of Pedal-operated cassava grater Grating Machine (Adetunji, O. R., & Quadri, A. H. 2011)

Advantages of Pedal-Operated Cassava Grating Machines	**Disadvantages of Pedal-Operated Cassava Grating Machines**
Human-Powered: No electricity or fuel required	Physical Effort Required
Eco-Friendly: Low carbon footprint	Limited Production Capacity
Cost-Effective: Lower operational costs	Operator Skill Affects Output Consistency
Portable and Versatile	Potential Safety Risks
Adjustable Speed and Control	Regular Maintenance Required

2.5 Engine Powered Cassava Grating Machines

Some cassava graters are powered by internal combustion (IC) engines running either on petrol or diesel. Engines are used when higher grating capacities are required in areas without electricity or when a mobile cassava grater is required for grating cassava at different locations. Aideloje, Okwudibe, Jimoh, and Olawepo, (2018) developed, fabricated, and tested a mobile cassava grating machine with a petrol engine as the prime mover. The grating capacity is 55.79 kg/h and its production cost is Gh₵604.38. The main parts of the machine are the frame, hopper unit, grating drum, delivery channel, and ground wheels. It also has a pair of handles for pushing the purpose. The mode of operation involves starting the engine, allowing it to stabilize, and then feeding peeled cassava into the hopper. The rotation of the grating drum grates the cassava into a mash which is collected through the delivery channel. Figure 2.6 shows the isometric drawing of the mobile cassava grater.

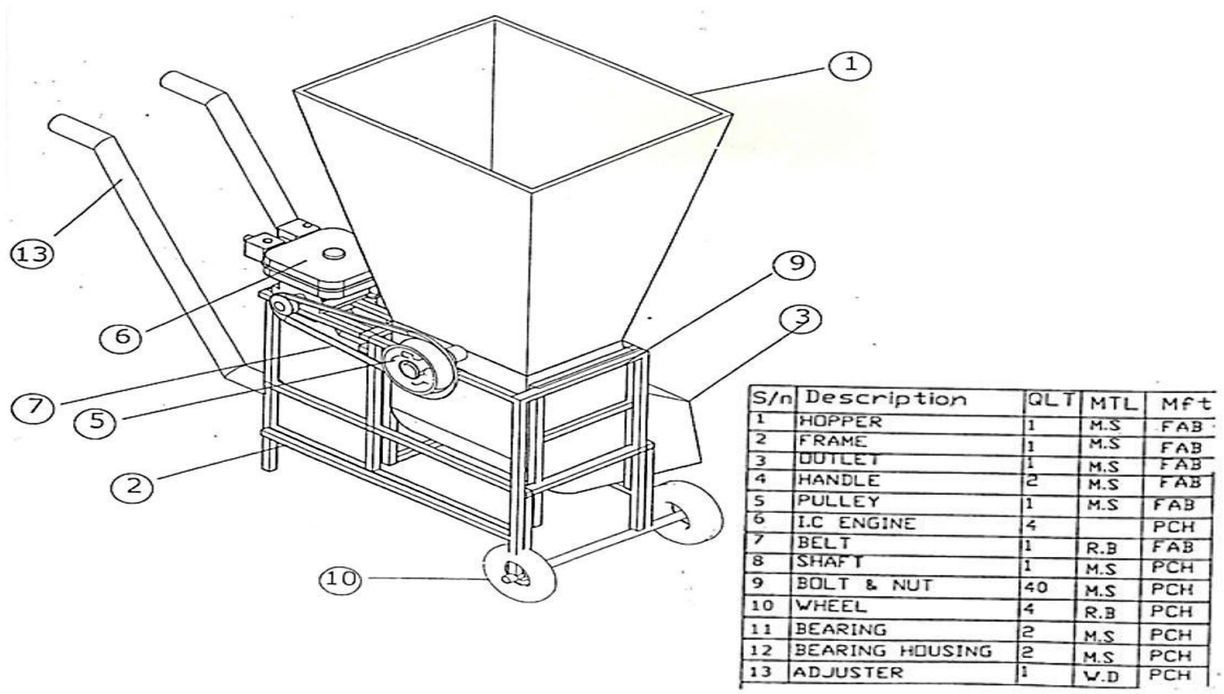


Figure 2.6: Isometric drawing of Mobile cassava grater (Aideloje et al., 2018)

Table 4. Advantages and Disadvantages of Mobile cassava grater Grating Machine (Adetunji, O. R., & Quadri, A. H. 2011)

Advantages of Engine-Powered Cassava Grating Machines	Disadvantages of Engine-Powered Cassava Grating Machines
High Production Capacity	Dependence on Fuel
Efficient and Faster Processing	Initial Cost and Operating Expenses
Consistent Output	Maintenance and Repair Requirements
Reduced Physical Effort	Environmental Impact
Suitable for Large-Scale Processing	Mobility Constraints

2.6 Electricity Powered Cassava Grating Machines

In recent times, electric motors are the preferred prime movers for stationary cassava graters at locations where electricity is available. This is because electric motors are compact, easy to start, and enhance a cleaner working environment compared to internal combustion (IC) engines.

Adetunji and Quadri, (2011) designed, fabricated, and tested a cassava grater powered by electricity through a single-phase medium-speed electric motor. The grater had a stainless-steel grating plate wrapped on the grating drum to improve the hygiene of the cassava mash. It had a grating capacity of 158 kg/h. however, the efficiency of the machine was not stated though it is a very important parameter in evaluating machine performance. Figure 2.7 shows drawings of the improved electricity-powered cassava grater.

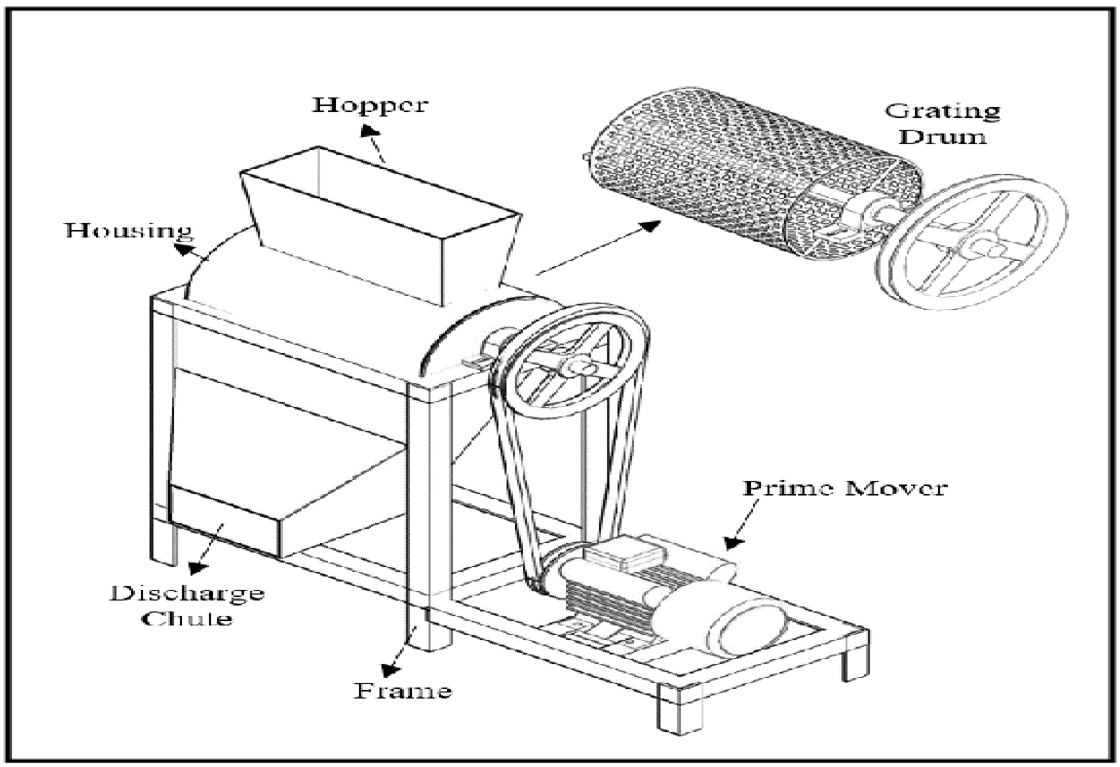


Figure 2.7 Electricity Powered Cassava Grating Machines (Darlene U. Esteves, Guillermo P. Pantuhan, Michelle O. Serviñas and Jane S. Malasador 2019)

Table 5. Advantages and Disadvantages of Electricity Powered cassava grater Grating Machine (Adetunji, O. R., & Quadri, A. H. 2011).

Advantages of Engine-Powered Cassava Grating Machines	**Disadvantages of Engine-Powered Cassava Grating Machines**
High Production Capacity	Dependence on Electricity Supply
Efficient and Faster Processing	Initial Cost and Operating Expenses
Consistent Output	Maintenance and Repair Requirements
Reduced Physical Effort	Environmental Impact
Suitable for Large-Scale Processing	Mobility Constraints

Electricity-powered cassava grating machines offer numerous advantages, but they also have some drawbacks. These factors are to be considered when evaluating the suitability of electricity-powered machines for cassava processing, especially in areas with reliable electricity supply.

CHAPTER THREE

DESIGN

3.1 Conceptual Design

3.1.1 Design 1

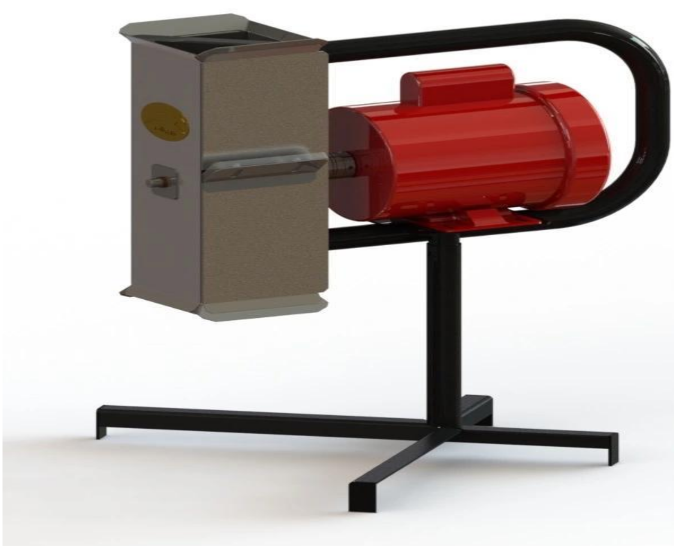
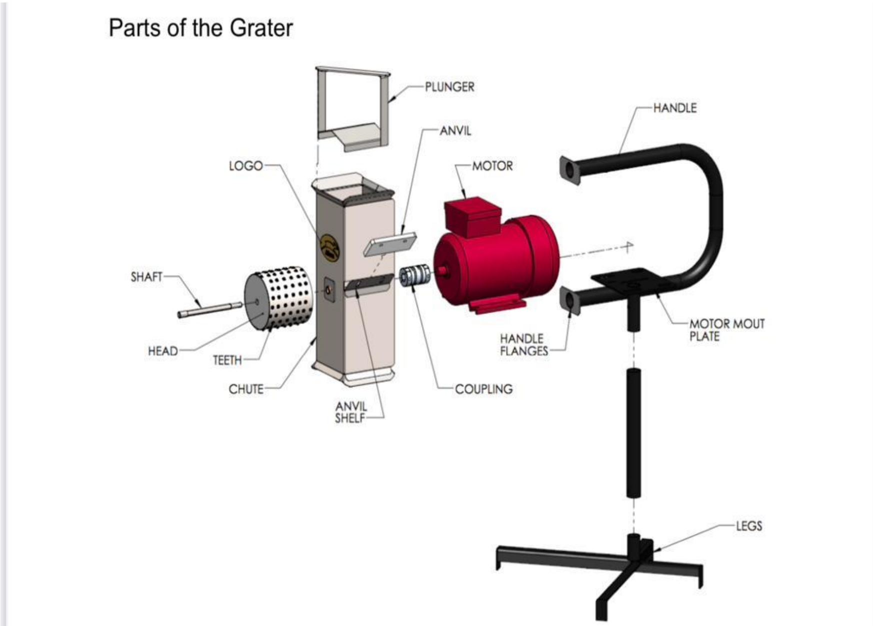


Figure 3.1 Design and development of a portable, off-the-shelf cassava grater in Ghana by students at Olin College (Ben Chapman and Ndungu Muturi 2015).



Exploded view of the design by (Ben Chapman and Ndungu Muturi 2015)

3.1.2 Design 2

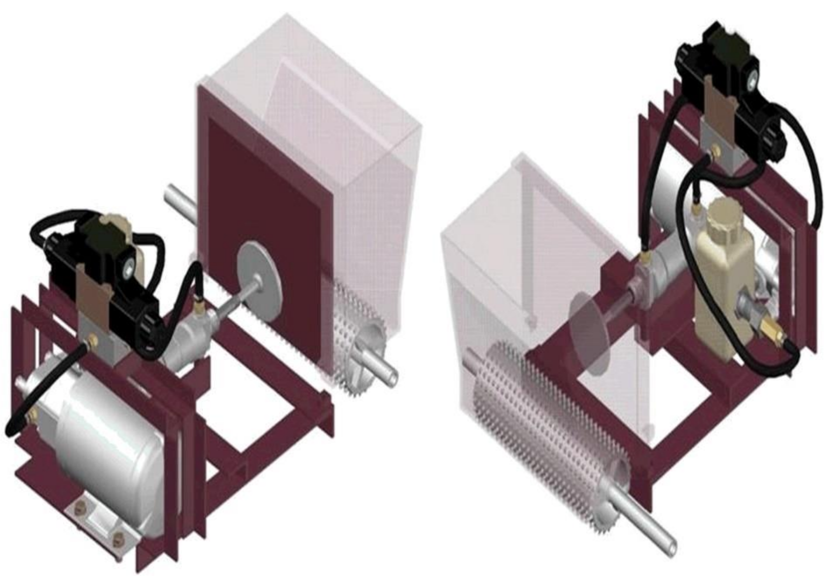


Figure 3.2 Development and testing of a double-action cassava grater with an automated contact plate (Kingsley Umani and Olugbenga Abiola Fakayode 2020)

3.1.3 Design 3

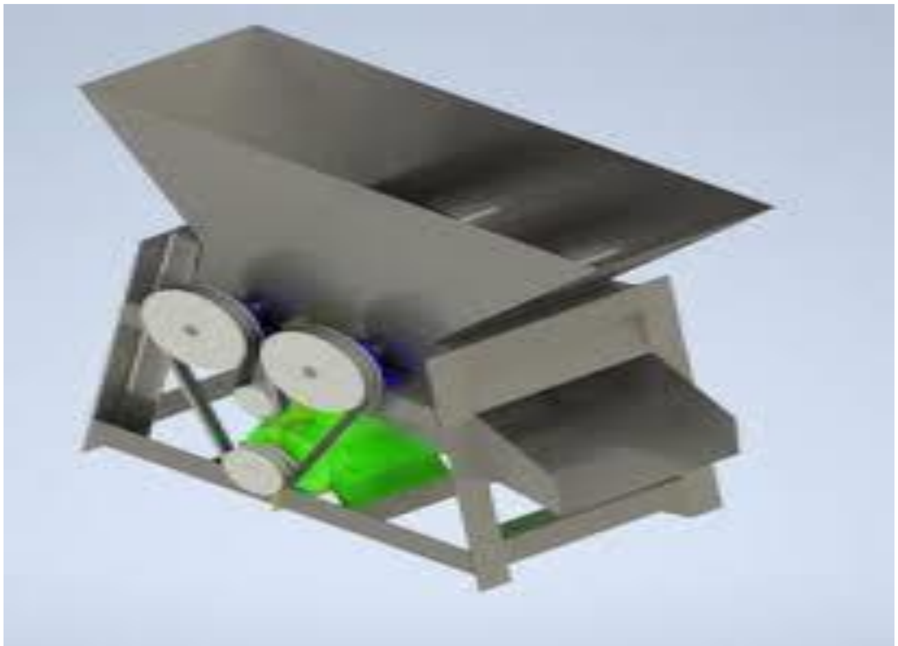


Figure 3.3 Design of an Improved Double Barrel Cassava Grating Machine (I.G. Okoli, U. C. Okonkwo 2021)

3.1.4 Design 4: Selected design

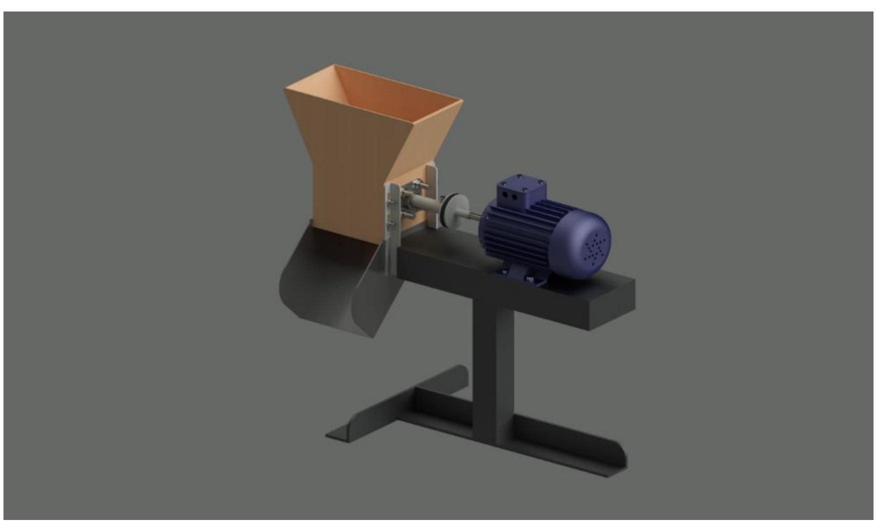


Figure 3.4 CAD Model of Selected design

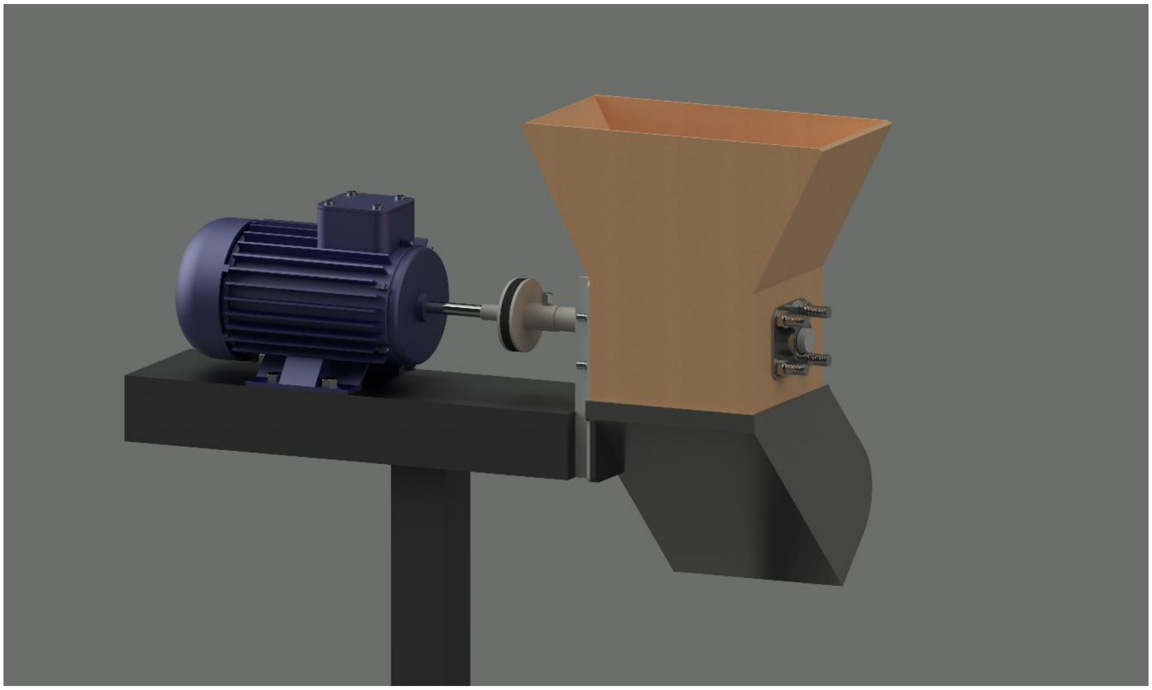


Figure 3.5 Back View

The parts list and function of the selected design is shown in Table 6

TABLE 6

Number	**Part Name**	**Quantity**	**Function**
1.	Hopper	1	Processed cassava roots enter hopper, directed towards grating device for processing.
2.	Shaft	1	The shaft is to provide rotational motion to the grating drum, which is responsible for shredding or grating the raw cassava roots

3.	Grating drum or unit	1	It's where the mechanical action takes place to break down the cassava into smaller pieces or shreds
4.	Bolt and Nut	16	Bolts and nuts hold cassava grater components together, facilitating assembly of drum, hopper, shaft, safety covers, and support structures.
5.	Flange Pillow Bearing	2	Flange pillow block bearings in cassava graters support, align, and facilitate smooth rotation, distributing loads, reducing friction, and enhancing machine efficiency and longevity.
6.	Flange Couple	2	Flange couplings transmit torque in cassava grating machines, connecting motor shaft to grating drum shaft, accommodating misalignments and ensuring proper alignment.
7.	Base or stand	1	The base or stand of a cassava grating machine provides stability, support, and alignment for all components, ensuring safe and efficient operation.
8.	Bearing	2	The bearing reduces friction, supports load, enable motion, provide accuracy, and also absorbs shock and vibrations.
9.	Motor	1	The motor is to provide the necessary power and rotational motion to operate the grating mechanism,

			enabling the efficient shredding of cassava roots into finer particles or shreds.
10.	outlet	1	The primary function of the outlet is to allow the processed grated cassava to exit the machine after it has been grated

3.2 Materials and Methods

3.2.1 Part 1 (Hopper)

Kingdom	**Family**	**Class**	**Member**	**Attributes**
Material	Wood	Maple plywood	Maple Tree	• Beautiful Appearance • Smooth texture • Finishing Qualities
Process	Joining	Woodworking Adhesives	Adhesives	• Non-Toxic Formulation • Resistance to Moisture and Heat • Easy to apply and clean
Process	Joining	Nails	Fastener	• Corrosion Resistance • Non-Reactivity

Process	Finishing	Painting	Paint spraying	• Attractive

Figure 3.6: CAD Model of the Hopper

3.2.2 Part 2 (shaft)

Kingdom	Family	Class	Member	Attributes
Material	Metal	Steel	Mild steel	• Affordability • Strength • Machinability
Process	Cutting	Lathe Machine	Turning	• Versatility • Precision • Dimensional control

				• Time efficiency
Process	Finishing	Sand Paper	Emery Cloth	• Smooth and polished finish • Attractive

Figure 3.7 CAD Model of the Shaft

3.2.3 Part 3 (Grating drum or unit)

Kingdom	**Family**	**Class**	**Member**	**Attributes**
Material	Wood	Maple wood	Maple tree	• Beautiful Appearance • Smooth texture • Finishing Qualities

Process	Cutting	Saw	Hacksaw	• Fine Tooth Pitch • Precision and control • Easy operation
Process	Cutting	Lathe Machine	Turning	• Versatility • Precision • Dimensional control • Time efficiency
Material	Metal	Tin	Non-Ferrous metal	• Soft and Malleable • Low melting point • Non-Toxic
Process	Cutting	Punch	Dot Punch	• Precision • Easy operation • Alignment aid

Figure 3.8 CAD Model of Grating unit

3.2.4 Part 4 (Countersunk Bolt and Nut) Purchased

Kingdom	Family	Class	Member	Attributes
Material	Metal	Steel	Mild steel	• High tensile strength • Corrosion Resistance
Process	Finishing	Polishing	Grinding	• Smooth surface finish

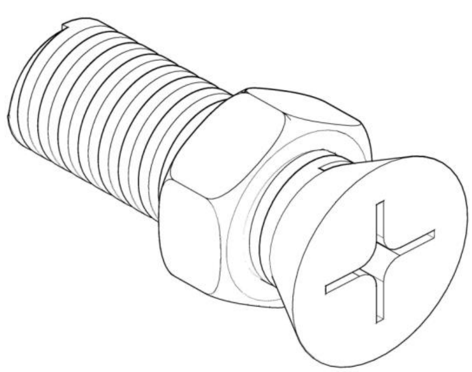


Figure 3.9 CAD Model of the Countersunk Bolt and Nut

3.2.5 Part 5 (Flage pillow bearing)

Kingdom	Family	Class	Member	Attributes
Material	Metal	Steel	Mild Steel	• Affordability • Strength

				• Machinability
Process	Cutting	Shears	Guillotine	• Accurate cutting • High precision • Easy to operate
Process	Cutting	Drilling	Bench Drilling machine	• Easy operation • High precision
Process	Cutting	Filling	Hand file	• Smooth finish • Easy to use • Versatility
Process	Joining	Welding	Metal Inet Gas (MIG)	• High deposition rates • Minimal cleanup • Good weld quality
Process	Cutting	Grinding	Angle Grinder (Flap disk)	• Smooth finish • Efficiency • Ease of use
Process	Finishing	Painting	Paint spraying	• Attractive • Neat finish

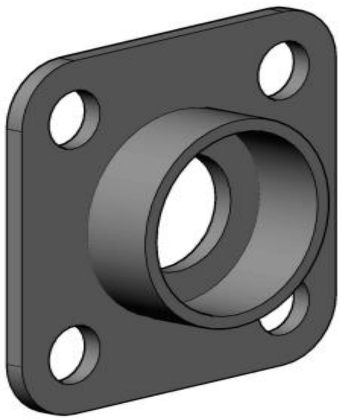


Figure 4.0 CAD Model of Flange Pillow bearing

3.2.6 Part 6 (Flange couple)

Kingdom	**Family**	**Class**	**Member**	**Attributes**
Material	Metal	Steel	Mild steel	• Affordability • Strength • Machinability
Process	Cutting	Shears	Bench Shears	• Versatility • Precision • Dimensional control • Time efficiency
Process	Cutting	Lathe Machine	Turning	• Versatility • Precision • Dimensional control • Time efficiency

Process	Joining	Welding	Metal Inet Gas (MIG)	• High deposition rates • Minimal cleanup • Good weld quality
Process	Cutting	Grinding	Angle Grinder (Flap disk)	• Smooth finish • Efficiency • Ease of use
Process	Finishing	Painting	Paint spraying	• Attractive • Neat finish

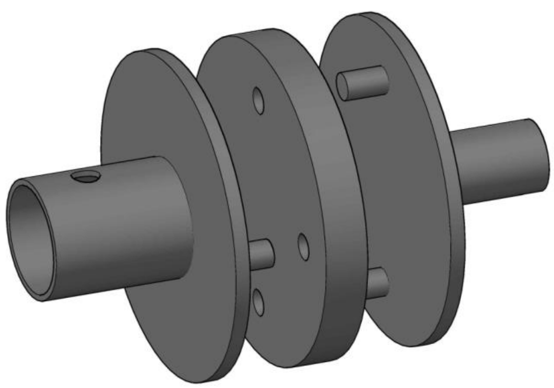


Figure 4.0 CAD Model of the Flange Couple

3.2.7 Part 7 (Base or Stand)

Kingdom	Family	Class	Member	Attributes
Material	Metal	Steel	Mild steel	• Affordability • Strength • Machinability • Weldability

Process	Cutting	Angle cutting Machine	Cutting disk	• Efficiency • Ease of use
Process	Cutting	Drilling	Bench Drilling machine	• Easy operation • High precision
Process	Joining	Welding	Electric Arc Welding machine	• High deposition rates • Good weld quality
Process	Cutting	Grinding	Angle Grinder (Flap disk)	• Smooth finish • Efficiency • Ease of use
Process	Finishing	Painting	Paint spraying	• Attractive • Neat finish

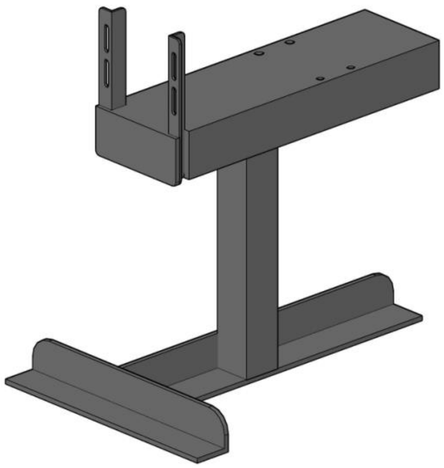


Figure 4.1 CAD Model of the base

3.2.8 Part 8 (Bearing) Purchased

Kingdom	**Family**	**Class**	**Member**	**Attributes**
Material	Metal	Steel	High carbon chromium steel	• Corrosion resistance • Toughness

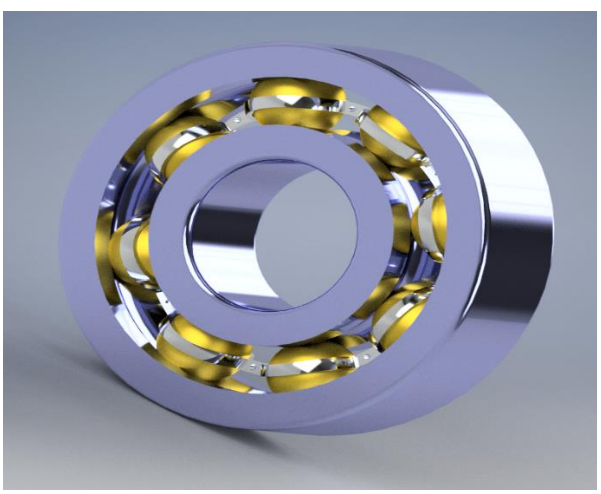


Figure 4.1 CAD model of Bearings

3.2.9 Part 9 (Motor) Purchased

Kingdom	Family	Class	Member	Attributes
Material	Metal	Iron	Cast Iron	• High Compressive Strength • Corrosion Resistance • Vibration Damping

Figure 4.2 CAD model of Motor

3.2.10 Part 10 (Outlet)

Kingdom	Family	Class	Member	Attributes
Material	Metal	Steel	Galvanized steel	• Corrosion resistant
Process	Cutting	Shears	Bench Shears	• Easy to operate • High accuracy
Process		Bending	Bending machine	• Bending accuracy • User friendly

Process	Finishing	Filling	Hand file	• Easy to use • Gives smooth finish

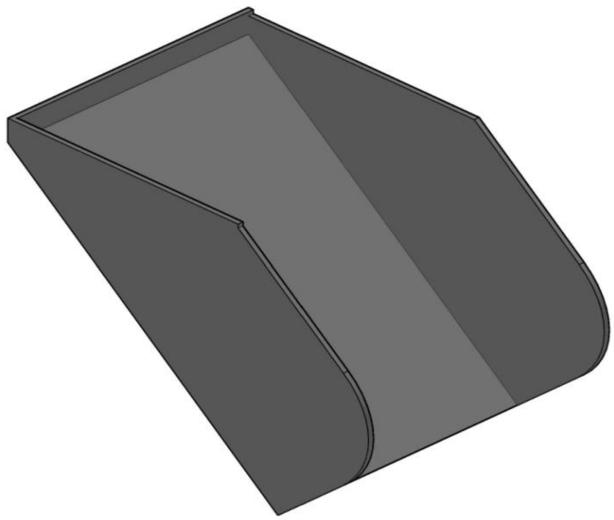


Figure 4.3 CAD model of the outlet

CHAPTER FOUR

FABRICATION AND ASSEMBLY

4.1 Introduction

This chapter summarizes the design and construction of the critical components of the cassava grating machine. It looks at the stress analysis of components and the specification of non-critical components. The analysis includes the strength of the motor, sizing of the shaft, bearing selection, the grating force, and the hopper capacity. The steps involved in the construction of the major parts are also explained.

The main methods used for this project were consultations and interactions with local cassava processors, and then a literature review of the internet on cassava grating equipment. Grounds research was used to come out with the conceptual designs, and their evaluation for the selection of one for further analysis. Literature from the internet and textbooks revealed how basic principles of science are applied to many processes and equipment.

4.2 Grating Unit

This unit is made up of the shaft, the grating wheel made of wood, a coupling, mounted on the table through a flange pillow bearing (Figure 4.2). The grating wheel is made up of a punched 0.9mm plate, wrapped on a 443mm diameter wooden wheel of 3mm and length of 105mm.

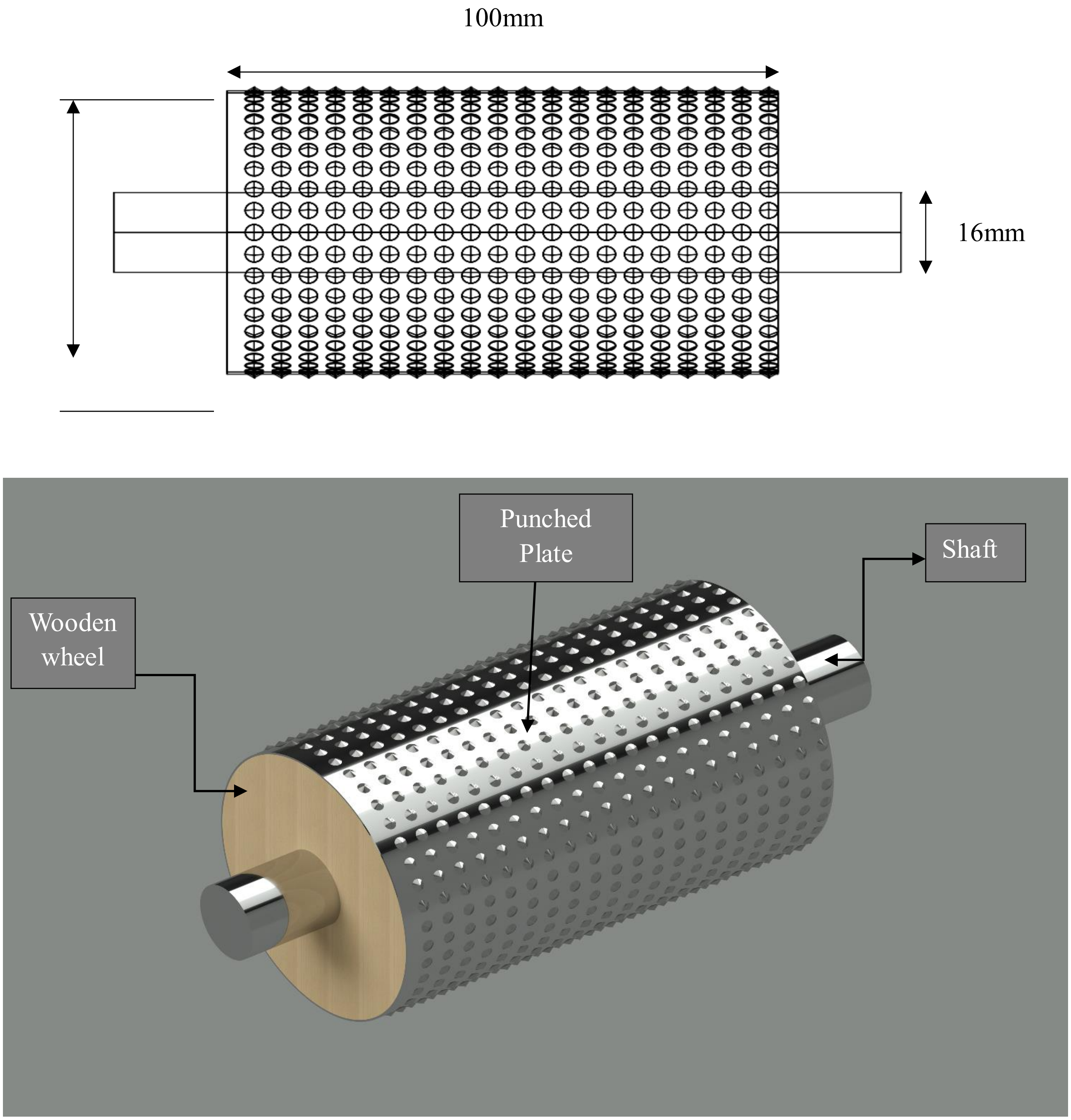


Figure 4.4 CAD Model of The Grating Unit

4.2.1 Wooden Wheel

In my cassava grating machine project, I focused on creating a safe and effective grating wheel made from maple wood (Figure 4.5). Maple wood is known to be safe for food and doesn't pose any risks of contaminating the cassava. This choice ensures that the cassava remains safe and healthy to eat, aligning well with the purpose of the machine in processing food.

The grating wheel plays a vital role in making the machine work properly. To make this wheel, I used a machine called a lathe. This machine helped me shape the maple wood into the right size and form. First, I fixed the wood in the lathe, and as the lathe spun the wood, I carefully used special tools to shape it. With patience and precision, I transformed the maple wood into a wheel that's 443mm in diameter and 105mm long.

This whole process was a combination of using the right materials and tools, like maple wood and the lathe machine, to create a grating wheel that works effectively in the cassava grating machine.

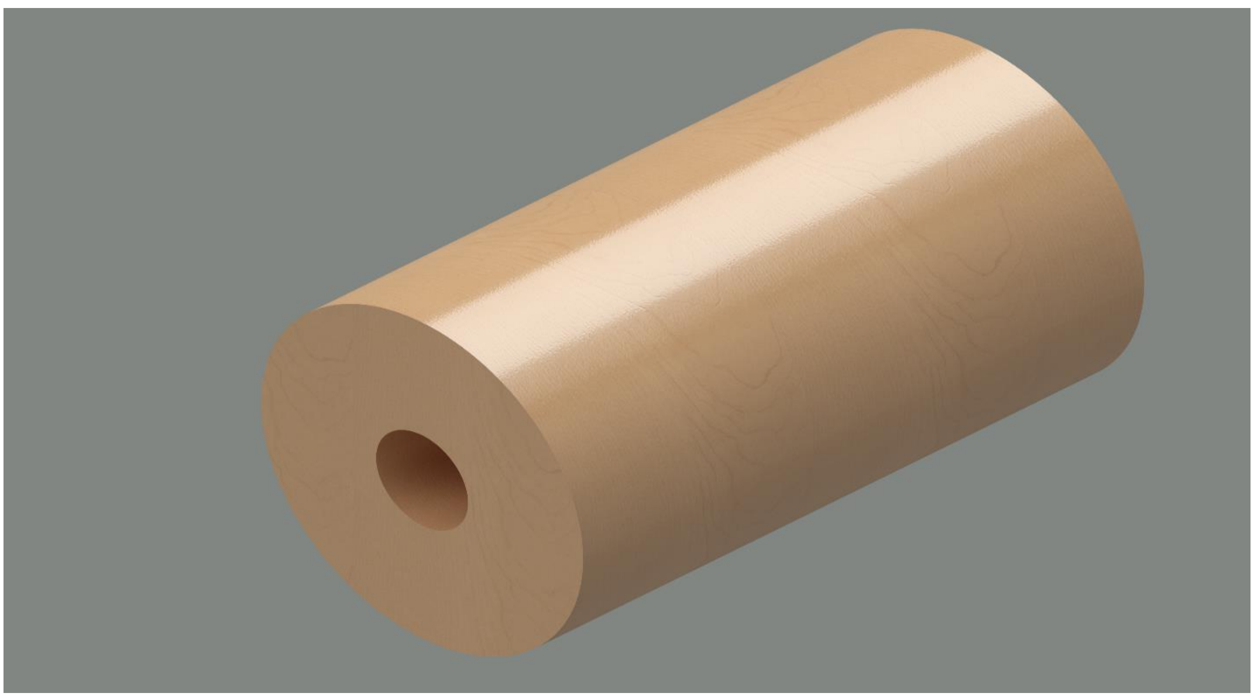


Figure 4.5 CAD Model of Wooden Wheel made from Maple wood

4.2.2 The Shaft Design

In this section, the correct diameter of the shaft was determined to ensure satisfactory strength and rigidity during the cassava grating process. The length (L) of the shaft had been pre-determined as 674mm. A free-body diagram of the shaft indicating the loads acting on it is shown in Figure 4.6. The forces at points B and D are reactions from the bearings whiles the forces at C and E are weights of the grating drum and flywheel respectively.

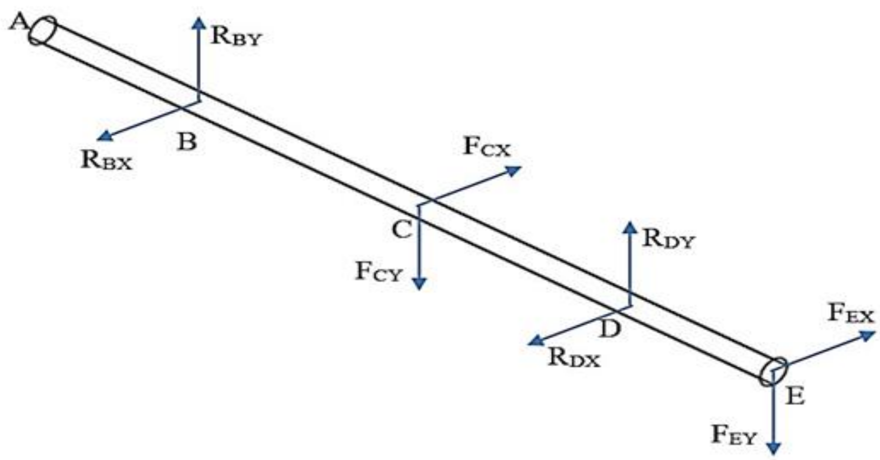


Figure 4.6 Free body diagram of the Shaft

The grater shaft was made from AISI 1020 low-carbon steel. And from standard tables, the properties of AISI 1020 (Appendix C) include tensile yield strength (Sy) of 295 Mpa, ultimate tensile strength (Su) of 395 mPa, and density of 7.87 g/cm3. Its modulus of elasticity (E) is 200GPa, and its poison ratio (V) is 0.290 (Azo Materials, 2015).

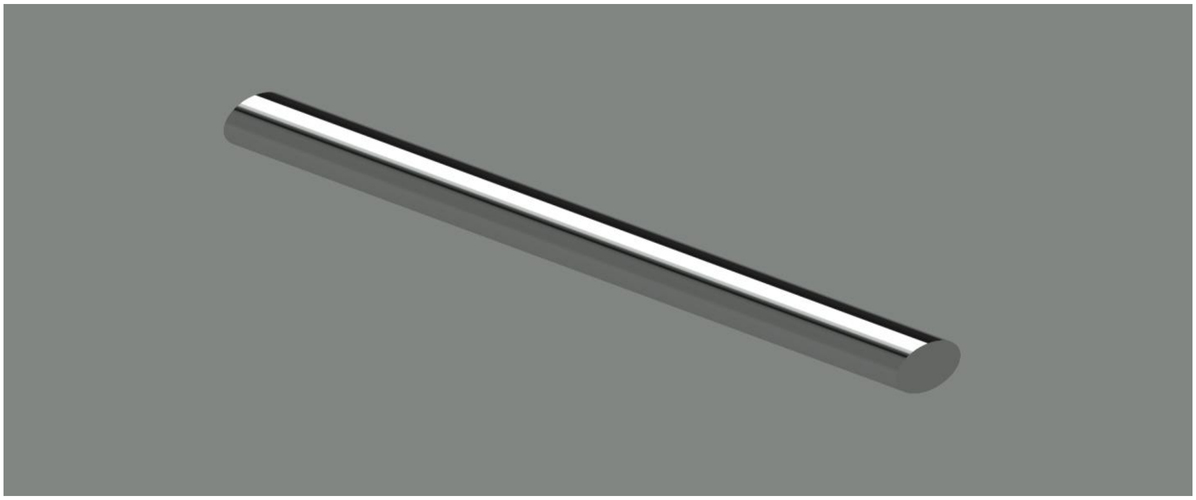
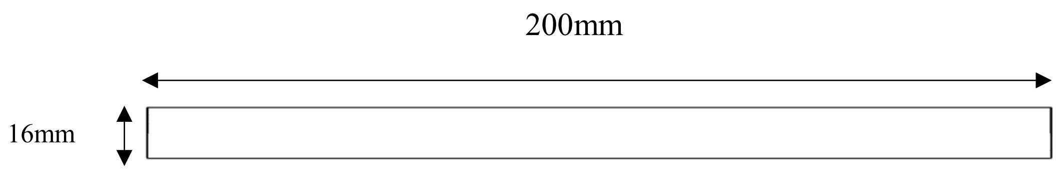


Figure 4.7 CAD Model of the Shaft

4.2.3 Sizing of the Shaft



Taking the diagram in Figure 4.7 into consideration, the maximum bending moment (M) will be calculated using;

$M = \frac{WL}{4}$ ………...**Equation 1**

Where: w = load on the shaft, and L = shaft length.

The grater shaft was designed based on its strength. The shaft material was mild steel, and it was considered to be subjected to combined twisting and bending moments. Maximum shear stress theory or Guest's theory was therefore applied. According to this theory, maximum shear (τ_{max}) stress is given by: (Khurmi and Gupta, 2005)

$\tau_{max} = \frac{1}{2}\sqrt{[(\delta_b)^2 + 4\tau^2]}$ ………...**Equation 2**

Where δ_b = stress due to bending moment, and τ = stress due to twisting moment.

The diameter of the shaft was calculated using the formula for an equivalent twisting moment (Equation 3) which was drafted from (Equation 2). (Khurmi and Gupta, 2005)

$T_e = \sqrt{(M^2 + T^2)}$ ………………………… **Equation 3**

Where:

T_e is the equivalent twisting moment

M is the maximum bending moment

T is the applied torque on the shaft

We also know the equivalent twisting moment to be

$T_e = \frac{\pi}{16} \times \tau \times d^3$ ……………………………………….. **Equation 4**

Where: d is the shaft diameter and τ is allowable shear stress.

4.2.4 Punched Plate

The punched plate acts as a grating surface where the cassava is pushed or rubbed against. The holes in the plate are strategically placed to allow the cassava to be forced through them, resulting in the cassava getting grated into finer pieces. The size and shape of the holes determine the size of the grated cassava.

The punched plate's design and arrangement of holes play a role in the efficiency of the grating process. Properly sized holes and spacing ensure that the cassava is grated evenly and quickly, minimizing the effort required to operate the grating machine

The punched plate is attached to a rotating mechanism in the cassava grating machine, such as the wooden wheel you. As the wheel rotates, the cassava is pressed against the punched plate, and the friction between the cassava and the holes causes the grating action to occur.

Preparation:

Ensure you have a suitable tin plate. The thickness of the tin plate was chosen based on the desired strength and durability for the cassava grating machine.

I select a dot punch with the appropriate diameter for the holes I want to create. The size of the holes will depend on the intended use of the cassava grating machine.

Marking the Hole Locations:

Use a ruler or measuring tape to mark the desired hole locations on the tin plate. I created a grid pattern because I wanted the holes to be evenly spaced or mark them based on your design.

Securing the Tin Plate:

I placed the tin plate on a sturdy surface or workbench. I secured it in place using clamps to prevent movement during the hole-punching process.

Using the Dot Punch:

I hold the dot punch at a 90-degree angle to the tin plate, with the pointed end of the punch facing down. I then positioned the punch tip directly over one of the marked hole locations.

Creating the Holes:

Gently I tap the dot punch with a hammer. Start with light taps to create a small indentation (center punch) at the marked location. This helped guide the punch and prevented slipping when I start creating the hole. Gradually I increase the force of your taps as I continued to hit the dot punch.

I continued this process for each marked hole location, being patient and consistent to ensure even and clean hole creation. Figure 4.8 show a CAD model of the punched plate.

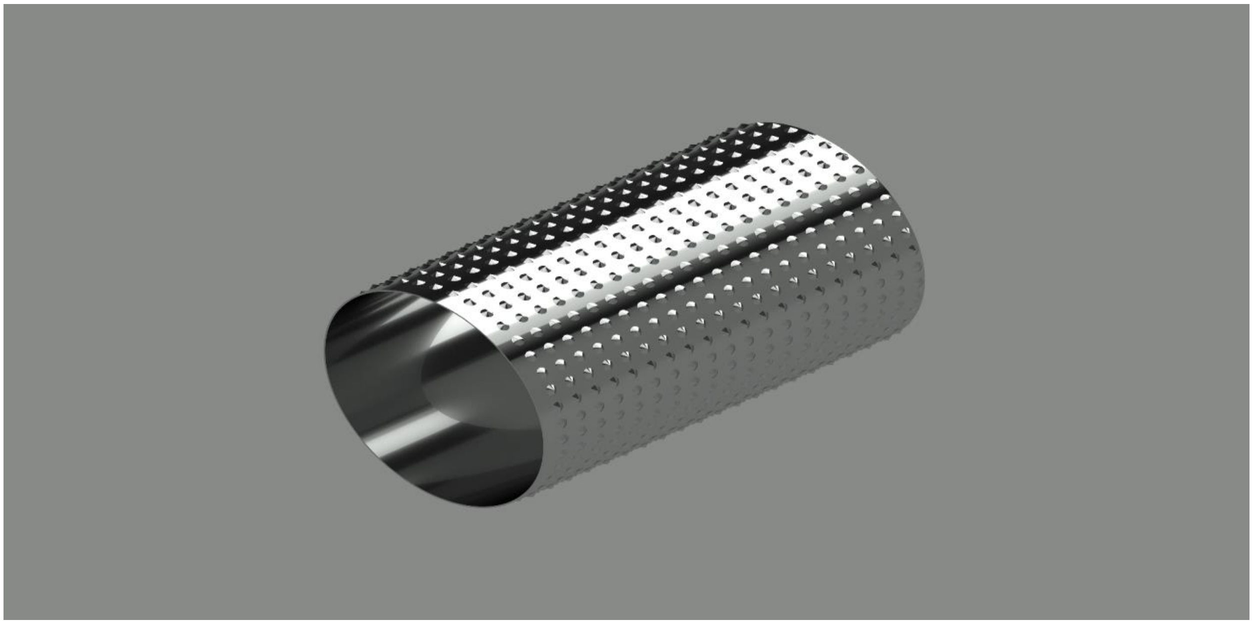


Figure 4.8 CAD Model of Punched Plate

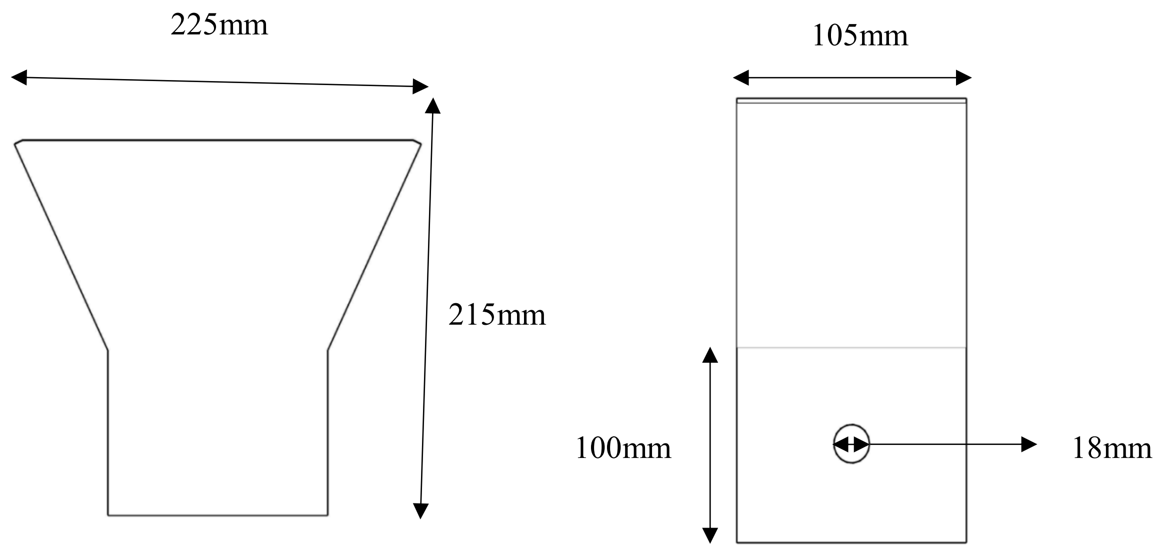
4.3 The Hopper

A hopper is a container or funnel-shaped device used to load raw materials into a machine. In the cassava grating machine, a wooden hopper serves as the entry point for the cassava before it goes through the grating process.

Design and Size

Determining the appropriate size and shape of the hopper based on the capacity of the cassava grating machine and the amount of cassava to be processed at a time.

The hopper's design allows easy and controlled feeding of cassava into the machine.



Materials and Construction

A durable wood material that is suitable for the environment and is food grade was used. Plywood, hardwood, or other sturdy types of wood are common choices and easy to get due to it availability. I cut and assembled the wooden pieces to create the hopper's structure. The hopper can have a funnel-like shape with a wider opening at the top for loading cassava and an opening at the bottom to guide the cassava towards the grating plate.

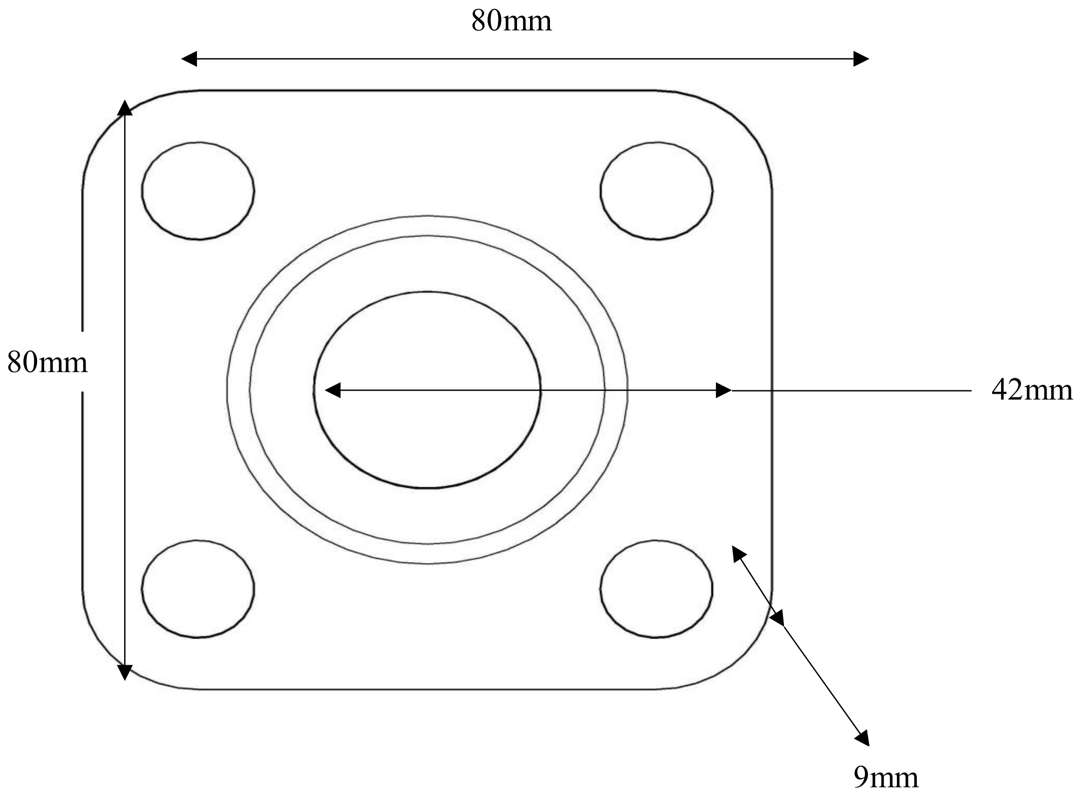
Nails and food grade adhesives were used in the joining process. I ensured that the hopper is securely attached to the machine's framework or structure. This was achieved through, bolts, and other appropriate fastening methods.

I made sure the hopper is aligned properly with the grating plate so that the cassava can be smoothly fed into the grating process. Figure 4.8 shows a CAD model of Hopper.

Figure 4.8 CAD Model of Hopper

4.4 Flange Pillow Bearing

A flange pillow block bearing, commonly referred to as a flange pillow bearing, is a type of bearing housing that is designed to support a rotating shaft while also providing a method of mounting the bearing to a surface (MDS 2019). This is typically achieved by bolting the flanged housing to a structure, such as a machine frame. Welding a flange pillow bearing case involves attaching the bearing housing to a metal surface through welding.



Preparation:

I ensured that both the flange pillow block bearing and the metal surface are clean and free from contaminants that could affect the welding process.

Check the specifications of the bearing to ensure it's compatible with welding. Some bearings might have seals or components that can be damaged by welding heat.

Alignment and Positioning:

The flange pillow block bearing was mounted on the metal surface ensuring that it's aligned correctly and level. Measuring tool was used to verify the alignment and make any necessary adjustments. I tacked welded the bearing housing to the metal surface at a few points. Tack welds are temporary welds that hold the pieces in place while you check and adjust alignment.

Once I was satisfied with the alignment and positioning, I proceeded with the final welding.

I choose the appropriate welding method by using the (MIG) and electrode or wire for the base metal and bearing material.

After ensuring the welds are sound, I cleaned the welded area using an angle grinder and other metal preparation tools to smooth any rough edges or excess material. Figure 4.9 Show the CAD model of the Flange pillow bearing,

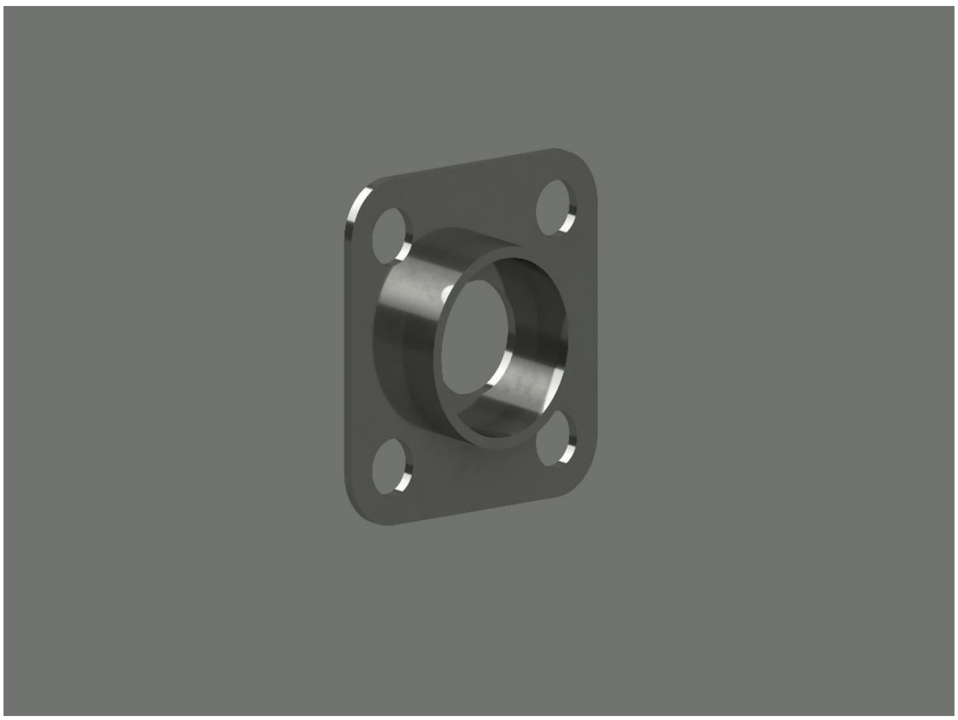


Figure 4.9 CAD Model of the Pillow Flange Bearings

4.4.1 Bearing

According to NSK (1998), the failure of bearings is not only caused by natural deterioration, however, errors in the selection process, improper design of bearing surroundings, incorrect mounting, and insufficient maintenance can also lead to conditions such as heat-seizure, fracture, scoring of bearing rings, and damage of seals or the cage.

In selecting the type and size of bearing for mounting the grater shaft, the factors that were taken into consideration include; the nature of the shaft, the mount surface condition, bearing life, strength, and rigidity. The speed factor, bearing load, and bearing life required by the Cassava grater was determined and the findings informed the choice of 6202-RS ball bearings.

The speed factor (f_n) was determined to be 1

$f_n = \left(\frac{10^6}{500\times 60n}\right)^{\frac{1}{3}} = (0.03n)^{1/3}$ ………………………….. **Equation 5**

where n = rotational speed of the shaft.

The bearing load (P) …………………………………………**Equation 6**

$P = F_r \times F_w$ …………………………………………………….. **Equation 7**

Where F_r = Radial load, and F_w = load factor

The bearing life rating was calculated using **Equation 8**

$L_h = \frac{10^6}{60n}\left(\frac{C}{P}\right)^{\frac{1}{3}} = 500F_h^3$ ……………………………. ……. **Equation 8**

Where F_h is the fatigue life factor given by

$F_h = f\frac{C}{P}$ ………………………………………………….. **Equation 9**

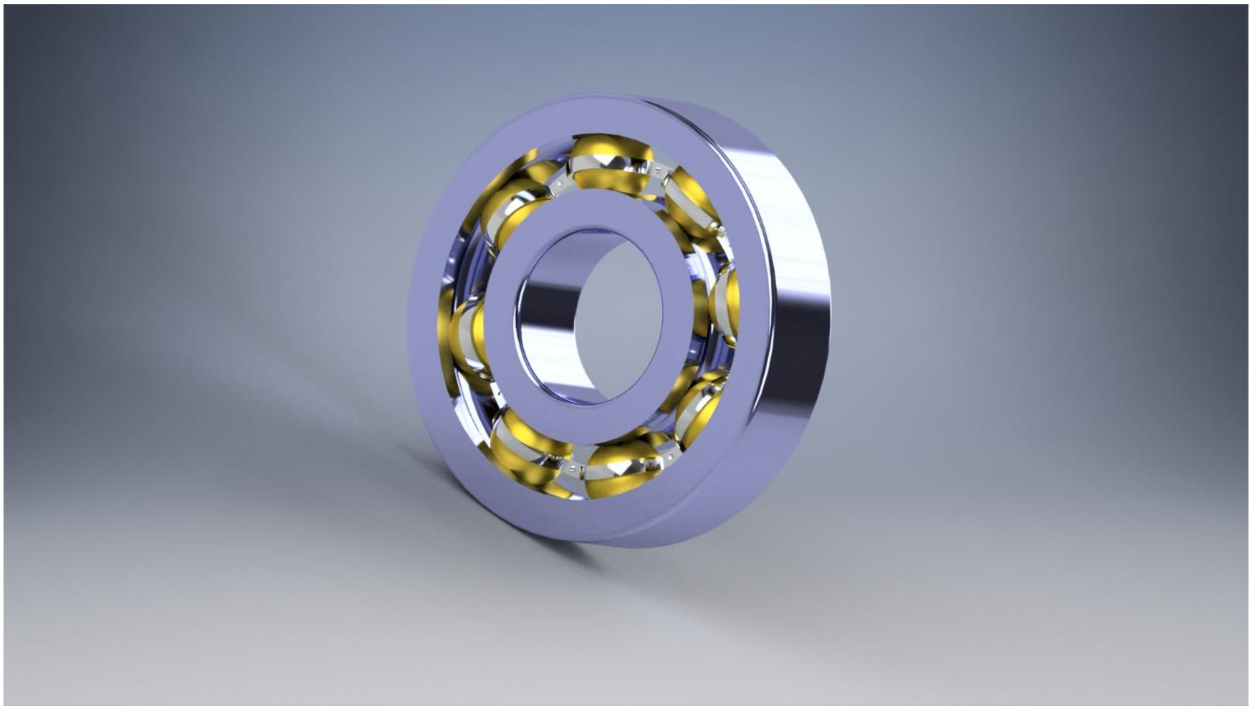


Figure 5.0 shows the bearing

4.5 Bolt and Nut

Bolts, fundamental components in engineering and construction, undergo a sophisticated and modern multi-step production process (thepipingmart 2022). These threaded fasteners possess an external male thread, engaging with a corresponding female thread, such as a nut. Bolts and screws share similarities.

Nuts, also fasteners, incorporate threaded holes and cooperate with matching bolts to secure multiple parts together (Jody Muelaner 2019). While bolts vary in size and shape, adhering to different specifications, their production process remains largely consistent.

The manufacturing of bolts initiates with cold forging. Large steel wires are unspooled and cut to specified lengths meeting ISO 898-1 standards (ISO 2013). Utilizing specialized tools, the cold-forged wire shapes into the required form. This method allows rapid, large-scale, and uniform bolt production. For intricate bolt designs exceeding cold forging's capabilities, supplementary turning or drilling processes might be applied.

Heat treatment, pivotal for all bolts, entails exposing them to elevated temperatures to strengthen the steel. Thread processing usually precedes heat treatment, either through rolling or cutting when the steel is malleable. Rolling, akin to cold forging, molds threads by passing bolts through a die. As heat treatment enhances steel hardness, pre-threading becomes more feasible and economical. Nuts and bolts serve diverse purposes, from constructing finished products to furniture assembly. These components are indispensable in crafting consumable final goods.

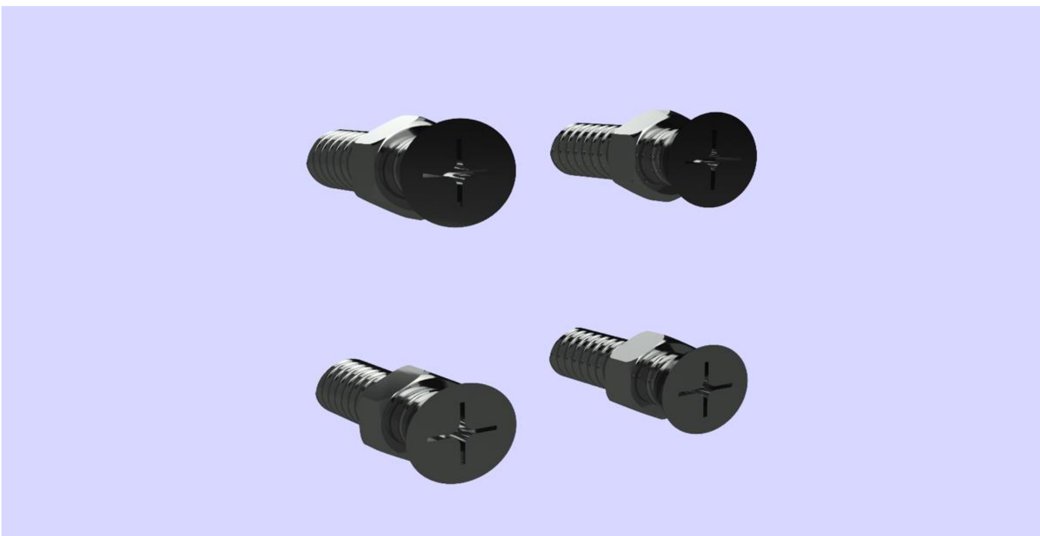


Figure 5.1 shows the countersunk bolt and nut

4.6 Flange Couple

Coupling is a device used to connect the shafts together for the purpose of transmitting power and torque. Generally, couplings are used for connection of shafts unit that are manufactured separately. Such as motor and generator; electric motor and centrifugal pump etc. Due to the inconvenience in transportation of shaft of greater length, it becomes necessary to join two or more shafts by means of coupling (Rani, s. G., hussain, p., & peera, a. G. A study and analysis of design and analysis of rigid flange coupling 2019).

During the manufacturing steps, I used mild steel since it was the available material and also has good properties such as easy to machine and also high weldability. I marked out using the compass to create a circular shape or form. With the help of the lathe machine, I turned it to the required diameter. That is 59mm. I cut a metallic piped to the diameter of the shaft 16mm and joined it to one end of each circular shape to create the flange.

Figure 5.2 shows the Flange Couple

4.7 Stand

This design is made of 40 x 40 mm mild steel angle iron with all joints produced through electric arc welding. It also has a rectangular top base with two legs inclined outwards at 90 degrees to the top base. However, the ends of the legs are curved to prevent shape edges. The legs are braced along the length of the frame to form two pairs of legs.

4.7.1 Material and Joining Technique

The entire design is constructed using mild steel angle iron, which is a common choice for providing structural support and stability due to its strength and durability.

Electric arc welding is used to create strong and secure joints between the various components of the design. Electric arc welding is a popular welding method that uses an electric arc to melt and fuse metals together, creating a strong and permanent bond.

4.7.2Frame and Legs

The main structure of the cassava grating machine is a rectangular frame, likely serving as the base and support for the grating components and other mechanisms.

The frame has two pairs of legs, positioned at the corners of the rectangle. Each pair of legs is inclined outwards at a 90-degree angle to the top base of the frame. This arrangement helps provide stability and support to the machine.

The ends of the legs are curved. Curving the leg ends is a safety measure to prevent sharp edges or protrusions that could pose a hazard to operators or interfere with the machine's operation.

4.7.3 Bracing

The legs are braced along the length of the frame. Bracing involves adding additional structural members (often diagonal supports) to reinforce the frame and legs, enhancing stability and preventing wobbling during operation. The bracing forms two pairs of legs, creating a robust and rigid structure.

This design prioritizes stability, safety, and durability. Using mild steel angle iron provided the necessary strength for supporting the machine and the forces it encounters during operation. Electric arc welding ensures secure connections between components, contributing to the overall stability of the machine. The incorporation of curved leg ends and bracing enhances safety and structural integrity.

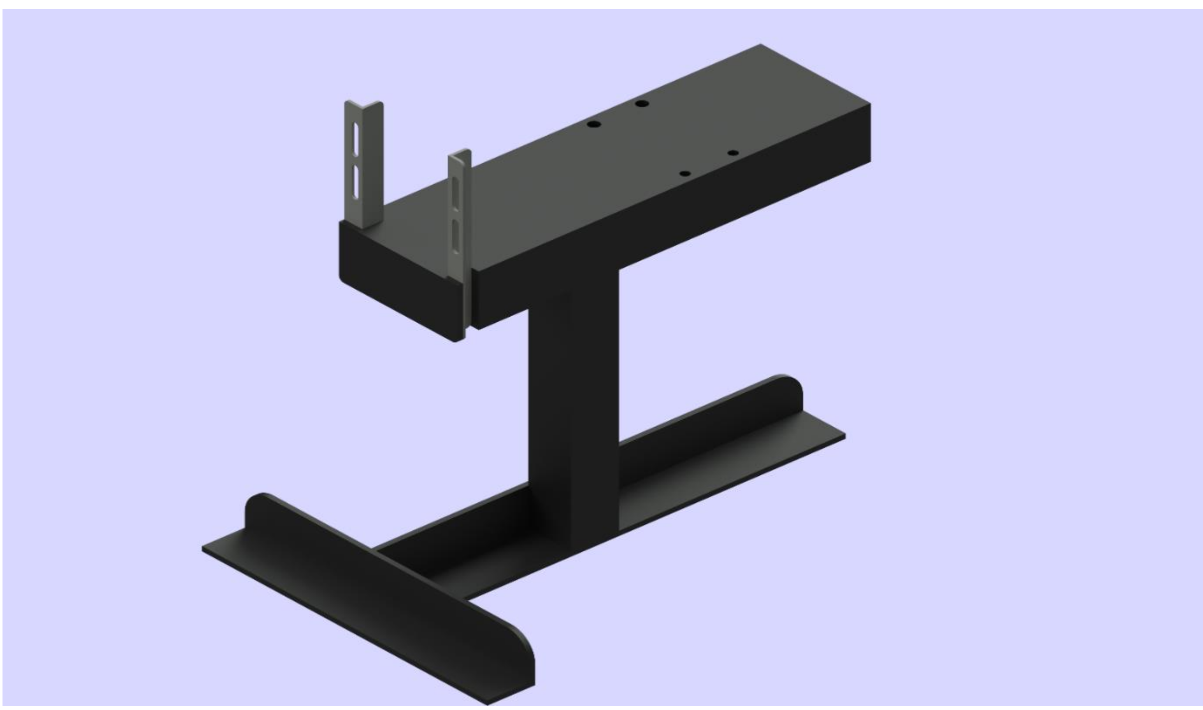


Figure 5.3 shows the Stand

4.8 Motor

A cassava grating machine, designed to efficiently grate cassava into smaller particles, benefits significantly from the utilization of a three-phase induction motor. These motors offer the required high starting torque to overcome the resistance presented by cassava's density and toughness, ensuring smooth and effective grating.

Their robust construction and suitability for continuous operation make them a perfect match for the demanding and prolonged tasks of cassava grating. Additionally, induction motors are known for their durability and low maintenance requirements, which are crucial factors in remote or less accessible locations. The motors' adaptability to variable loads and their energy efficiency further contribute to optimizing the grating process.

By integrating a three-phase induction motor, the cassava grating machine gains the reliability, power, and efficiency needed to efficiently process cassava into desired forms.

The housing of a three-phase induction motor is mostly made of Cast. Die casting is widely recognized as a low-cost rotor cage manufacturing process. For this reason, die-casting has become the fabrication method of choice and aluminum the conductor of choice in all but the largest frame motors. High-pressure die-casting of aluminum squirrel-cage rotors is a mature process performed by most of motor manufacturers. The melting point for aluminum alloys is in the 670 °C range and the material used for the rotor’s die-casting mound is not highly stressed at these temperatures. Die life can be in the hundreds of thousands of rotors depending on die complexity (Parasiliti, F., Villani, M., Paris, C., Walti, O., Songini, G., Novello, A., & Rossi, T. (2004, June). Three-phase induction motor efficiency improvements with die-cast copper rotor cage and premium steel. In Proceedings of SPEEDAM’04 Symposium).

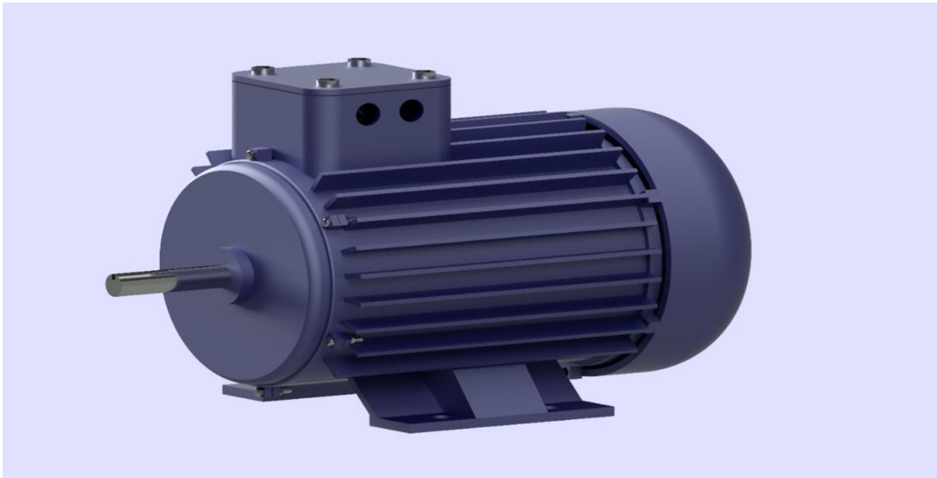


Figure 5.4 shows the Motor

4.9 Outlet

The primary function of the outlet is to allow the processed grated cassava to exit the machine after it has been shredded or grated. This facilitates the continuous operation of the machine by ensuring a smooth flow of processed material out of the grating section.

The outlet provides a point where the processed cassava can be collected and stored for further processing or packaging. The grated cassava can be collected in containers, bags, or conveyed to subsequent processing stages.

The outlet provides a point where the processed cassava can be collected and stored for further processing or packaging. The grated cassava can be collected in containers, bags, or conveyed to subsequent processing stages. The outlet's design prioritized operator safety, ensuring that there are no points of contact with moving parts or potential hazards as the grated cassava exits the machine. The outlet was made with galvanized metal. I marked it out and bend it using the bending machine to transform the plate to 90° to achieve a rectangular shape.

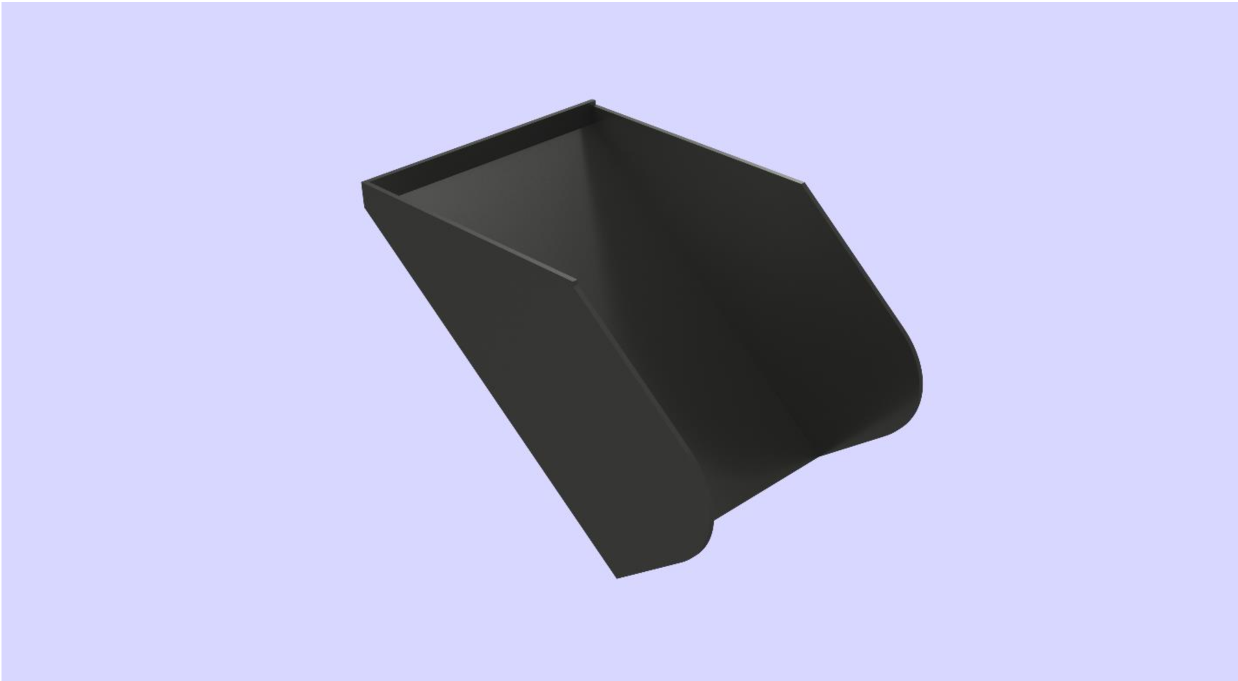


Figure 5.5 shows the outlet

4.10 Picture of final design after assembling

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The main aim of this project was to design and fabricate a motorized cassava grating machine. This chapter concludes the project work and discusses some of the challenges I faced during this project work. It also talks about things that could have been done better and give recommendation to it.

5.2 Summary of the project work

5.2.1 Designing a Motorized Cassava Grating Machine

The project aimed to create a design for a cassava grating machine powered by a motor. This design would incorporate features for efficient cassava processing. During the designing stage AutoCAD software as used for the designing to create detailed plans and drawings for the. Cassava grating machine. AutoCAD helped me visualize and refine the machines appearance, making sure it was accurate. This software made designing the machine easier, and it played a big part in the project's success.

5.2.2 Fabricating the Motorized Cassava Grating Machine

The project involved the physical creation of the motorized cassava grating machine. The machine was to be constructed using electrical energy as its power source, with the intention of enhancing the cassava processing process. During the fabrication stage I acquired the motor required for the cassava grating machine at Magazine Kumasi and then proceeded with the fabrication process at the workshop in AAMUSTED. Along the way, I made thoughtful modifications and enhancements to the motor. These changes were implemented to optimize its performance, ensuring that it would efficiently and effectively meet its intended purpose thus converting from three inductions to single phase induction. This hands-on approach allowed me to tailor the machine to specific requirements, resulting in a final product that exceeded initial design expectations.

5.2.3 Testing of grating machine

Originally, the project intended to assess the machine's grating capacity and efficiency in comparison to the traditional hand grating method. That's the speed at which the machine grate compared to the traditional hand method. And also comparing the quality of the grated cassava produced from both the hand grating method and the motorized grating methods. Thus, the quality of grate, the size and texture of the grated cassava.

In summary, your project involved designing and fabricating a motorized cassava grating machine powered by electrical energy. While you had planned to compare its efficiency and capacity with the traditional hand method, challenges in testing prevented the full execution of this aspect of the project.

Design Planning: The first step was to create a detailed design plan for the cassava grating machine. This plan included dimensions, materials, and the layout of components, with specific attention to the wooden hopper.

Material Selection: Wood was chosen as the primary material for the hopper due to its availability, affordability, and ease of working with. The type of wood used was selected based on its strength, durability, and resistance to moisture.

Hopper Construction: The wooden hopper was fabricated using the chosen type of wood. The pieces were cut and shaped according to the design specifications. Tools like saws, chisels, and sanders were used to achieve the desired shape and dimensions.

Joinery: Joinery techniques such as mortise and tenon joints, screws, and glue were employed to assemble the various parts of the wooden hopper. This ensured a sturdy and secure construction.

Frame Construction: Apart from the hopper, the frame of the cassava grating machine was constructed using metal or other suitable materials. This frame provided the structural support for the entire machine.

Motor Installation: The motor was positioned in a way that it could efficiently power the grating mechanism. Proper alignment and mounting were crucial for the motor's effective operation.

Grating Mechanism: The grating mechanism, likely made of metal, was attached to the machine. This mechanism would actually process the cassava and turn it into finer particles.

Integration: The wooden hopper was securely attached to the machine's frame. The hopper needed to be properly aligned with the grating mechanism to ensure smooth and efficient feeding of cassava.

Finishing: The wooden hopper might have been treated with protective finishes to increase its resistance to moisture and wear, ensuring its longevity.

5.3 Challenges

- Ensuring that the design is well-suited for the intended purpose and that it can accommodate the mechanical and operational requirements of the grating machine. During the material selection, the intended material for the hopper was supposed to be stainless steel sheet metal but due to high-cost, wood was chosen to replace it. Selecting a type of wood that is both strong and durable, while also being resistant to the moisture and wear that it will encounter during cassava processing.

- Achieving precise dimensions and angles during the construction of the wooden hopper to ensure that cassava feeds smoothly and evenly into the grating mechanism. And also, achieving strong and secure joints between wooden components to prevent wobbling, misalignment, or weakening of the hopper over time.
- With the frame construction, ensuring that the frame is structurally sound and capable of supporting the weight and forces generated during cassava processing. Properly aligning and mounting the motor to ensure efficient power transmission to the grating mechanism without causing undue stress on the components was another challenge I faced during the manufacturing steps.
- Designing and fabricating the grating mechanism to effectively transform cassava into finer particles while ensuring that it's durable and easy to maintain. Applying protective finishes to the wooden hopper that are not only effective in preventing moisture damage but also safe for food contact and consistent with health and safety regulations.
- Rewiring of the three-phase induction motor that is converting it to single-phase induction motor was a biggest challenge. This can result to imbalance of the motors magnetic field leading to overheating. This cause loss power ie. Power reduction an also shorten the life spam of the motor.

5.4 Lessons Learnt

I learned important things while making the cassava machine with a wooden hopper. Picking the right wood was key because it needed to work well with cassava. Making things accurately was super important too, so the machine worked right and was safe. Putting all the parts together, like the wood, motor, and grating part, needed careful planning so they fit and worked smoothly. Safety was key; we had to make sure the machine was safe to use. Also, making the machine practical was more important than how it looked. Figuring out the time, materials, and tools we needed was also a big lesson to avoid problems. Looking back, we realized that being able to adjust when things go wrong is really helpful. Keeping records of what we did and learning from others were useful, and working with different people made the project better. These lessons will help us do better in the future.

5.4 Recommendation

- With the hopper, wood was used but stainless steel would have been a better option due its durability and aesthetics. Stainless steel is very easy to clean compared to wood.
- Single phase induction motor is a better option compared to three phase induction motor. This is due to the fact that the machine will be mostly used for domestic purposes and most home are wired with single phone power hence the machine will be restricted to homes with three phase wiring. So, it is advisable that you buy single phase induction motor to suit the work for it intended purpose to avoid any merit with converting three phase induction motor to a single-phase induction motor.

REFERENCES

Adetunji, O. R., Sc, M., Quadri, A. H., & Sc, B. (2011). Design and Fabrication of an Improved Cassava Grater . *The Pacific Journal of Science and Technology*, *12*(2), 120–129. Retrieved from www.akamaiuniversity.us/PJST.htm

Aideloje, V. E., Okwudibe, H. A., Jimoh, A. Z., & 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.

Apodi, J., Akidiweasagadunga, P., & Kwablaamedorme, S. (2018). Design and Construction of a Manually Operated Cassava Grating Machine for the Post Harvest Unit of the Department of Agricultural Engineering of Bolgatanga Polytechnic. *International Journal of Advanced Research in Science, Engineering and Technology*, *5*(10), 7091–7098. Retrieved from www.ijarset.com

Parasiliti, F., Villani, M., Paris, C., Walti, O., Songini, G., Novello, A., & Rossi, T. (2004, June)

George, O. (2018). Field Measurements and Statistical Analysis of Perforated Grating Surfaces for Grating Fresh Cassava into Mash in Ghana. *Afr. J. Food Agric. Nutr. Dev.*, *18*(2), 13451–13469. https://doi.org/10.18697/ajfand.82.17285

Jones, W. O. (1959). Manioc in Africa. *Manioc in Africa.*

Khurmi, P. S., & Gupta, J. K. (2005). A textbook of machine design. In *System*.

Kleih, U., Phillips, D., Wordey, M. T., & Komlaga, G. (2013). *Cassava Market and Value Chain Analysis: Ghana Case Study.* Accra, Ghana.

Kolawole, P. O., Agbetoye, L., & Ogunlowo, S. A. (2010). Sustaining world food security with improved cassava processing technology: The Nigeria experience. *Sustainability*, *2*(12), 3681–3694. https://doi.org/10.3390/su2123681

Ndaliman, M. B. (2006). Development of Cassava Grating Machine : A Dual-Operational Mode. *Leonardo Journal of Sciences*, *1*(July 2006), 103–110.

Nimoh, F., Asare, G. O., Twumasi, I., & Anaman, R. (2018). Consumers' willingness to consume cassava leaves as a leafy vegetable in the Kumasi Metropolis, Ghana. *International Journal of Food Studies*, *7*(2), 38–50. https://doi.org/10.7455/IJFS/7.2.2018.A4

NSK. (1998). NSK Rolling Bearings Catalogue. *Motion and Control*, *1*, 1–279.

Nuer, A. T. K. (2010). *Sustaining Rural Technology Transfer Under Rural Enterprises Projects (a Case Study of Cassava Processing Technologies in Rural Ghana)*.

Nweke, F. I. (2005). A Review of Cassava in Africa with country case studies on Nigeria, Ghana, the United Republic of Tanzania, Uganda, and Benin 2. *FAO and IFAD*.

Opandoh, D. (2015). *Standardization of the grating surface of cassava graters for gari*.

P. A. Asare1, I. K. A. Galyuon2, E. Asare-Bediako1*, J. K. S. and J. P. T. (2014). Phenotypic and molecular screening of cassava genotypes for resistance to cassava mosaic disease. *Journal of General and Molecular Virology*, *6*(2), 30.

QUADRI, A. H. (2010). *Design and Fabrication of an Improved Cassava Grater*. Thesis.

Quaye, W., Gayin, J., Yawson, I., & Plahar, W. A. (2009). Characteristics of various cassava processing methods and the adoption requirements in Ghana. *Journal of Root Crops*, *35*(1), 59–68.

Richard Bayitse, Ferdinand Tornyie, A. B. B. D. (2019). Cassava cultivation, processing, and potential uses in Ghana. *ResearchGate*, *1*(January 2019), 313–333. Retrieved from https://www.researchgate.net/publication/320234151%0ACassava

Westby, A. (2009). Cassava utilization, storage, and small-scale processing. *Cassava: Biology,* *Production, and Utilization*, *1*, 281–300. https://doi.org/10.1079/9780851995243.0281

Yusuf, Ko; Akpenpuun, TD; iyanda, M. (2019). Design and Fabrication of a Simple Pedal Operated Cassava Grater Suitable for Rural Dwellers *Yusuf, KO; Akpenpuun, TD; Iyanda, MO. *J. Appl. Sci. Environ. Manage.*, *23*(6), 1007–1011.

Zvinavashe, E., Elbersen, H. W., Slingerland, M., Kolijn, S., & Sanders, J. P. M. (2011). Cassava for food and energy: exploring potential benefits of processing of cassava into cassava flour and bioenergy at farmstead and community levels in rural Mozambique. *Biofuels, Bioproducts and Biorefining*, *5*(2), 151–164.