

**DESIGN AND FABRICATION OF MELON SHELLING  
MACHINE**

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**DECEMBER, 2022**

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**IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR  
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UNIVERSITY OF BENIN, BENIN CITY, NIGERIA.**

**DECEMBER 2022**

## CERTIFICATION

This is to certify that this work was successfully carried out by OVWEMU ELVIS OGHENEMUDIA with matriculation number ENG1604457, Department of Production Engineering , Faculty of Engineering , University of Benin, Benin City in partial fulfillment of the requirement for the award of Bachelor Engineering degree of the University of Benin, Benin City, Edo state, Nigeria.

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## **DEDICATION**

This work is wholly dedicated to the Lord God Almighty for His grace and guidance before, during and after the course of this project and as well as to my late dad Mr Henry Ejiroghene Ovwemu

## **ACKNOWLEDGEMENT**

My gratitude goes to Almighty God for His guidance, protection and provision towards the success of this work.

I am particularly grateful to my supervisor Engr. Dr. E. Ikpoza for his academic and moral contribution in the completion of this work. This appreciation is extended to all members, especially the Technical staff of the Department of Production Engineering, University of Benin who contributed in one way or the other in making this work a reality.

I also want to thank my elder brother Mr Otega Ovwemu for his consistent encouragement throughout my

years in school, also my other wonderful siblings, I can't thank you guys enough.

Finally, I appreciate my project member bright who gave me a great deal of encouragement and advice in difficult moments during the course of this work. Thanks for always being there for me.

## ABSTRACT

Melon seed is an important oil seed crop which serves several food purposes. Shelling of this crop is vital, prior to its vast applications. To address the challenges associated with shelling melon, a design for shelling melon seeds on a small scale was presented and evaluated.

Parameters evaluated include shelling efficiency, percentage seed shelled and damaged, throughput and machine capacity. The machine was constructed using locally available materials and consists of a hopper, frame, shelling and cleaning unit. Shelling operation was carried using melon seeds of three different moisture contents (6.99, 11.90 and 18.32%) and at different shelling speeds of 1500 and 1450rpm, while performance evaluation were evaluated.

Results obtained showed that shelling speed of 1500rpm for seed A has the best average shelling efficiency of 53.75% and least percentage seed damage of 22.6%, compared to shelling speed of 2500rpm seed B which had average shelling efficiency of 37%. This design and set of conditions selected were the most preferred because of the low-cost, rapid operation, lesser seed damage and minimal human energy expenditure. The melon seed sheller is user friendly, does not require skilled labour. The equipment design was found suitable for rural development.

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# CHAPTER ONE

## INTRODUCTION

### 1.1. Background to study

According to Aguayo and Artes, (2004), melon has 18 metric tons of grown annually, and the fourth most important crop in the world in terms of production. It is also one of the highly cultivated and consumed oil seed crop in Nigeria and West Africa. The main cultivars found in Nigeria are Bara, Serewe and Sofin. Bara which is also known as papa has large brown seeds with thick black edges thickened towards the apex, about 16 x 9.5 mm and is common in the northern and western part of Nigeria. They are also found in eastern Nigeria and its shelled kernel could be grounded into thick paste or sprinkled into a soup or a stew and can be used as raw material in the production of margarine, salad local pomade, soap while its shell could be used as poultry litter (Bankole et al., 2010; Egbe et al., 2015; Shittu and Ndrika, 2012; Ogbe and George, 2012). Melon seeds are highly nutritious, providing the human diet with good quality proteins of about 26.2-37.4% and oil content of about 47.3-50 (Norton, 1993; Ogbonna and Obi, 2007; Ajibola, et al., 1990; Omidiji, 1997). It contains about 41.51% essential amino acids and other essential nutrients (Sabo et al, 2015; Achu et al., 2005).

Melon seed is also a good source of minerals, vitamins, oil and energy in form of carbohydrates (Olaniyi, 2008). Through fermentation, coring, washing, drying, shelling and oil extraction it can be processed to further diversify its use (James et al., 2011; Nwakire et al., 2011).

Shelling and cleaning is considered one of the important postharvest processing of melon to its finished products. However, this operation is usually associated with some impediments such as high expenditure of human energy. The inability to effectively shell melon to meet the requisite capacity necessary for industrial utilization is also a great hindrance to its use for large scale

production of various commodities (Adekunle et al., 2009). This conventional, traditional or manual method of shelling melon according to Pradhan et al, (2010), is considered to be inefficient, tedious and time consuming, such that the availability of their products in the market is limited. In addition, such unmechanized method also results in bruising and serious injury to the human fingers, coupled with low productivity (Nkakini, et al., 2007).

It is expedient that small and medium scale farmers in Nigeria have a satisfactory, cheap and effective means of mechanized melon shelling technique. However, there exist different forms and types of melon shellers according to the source of power which can be classified as, manually, electrically powered or fuel-driven melon shellers. Several researchers have reported the result of investigating the development and use of mechanical systems to address the problems associated with the traditional methods of shelling. Also, substantial research work has been carried out on mechanical melon devices to ease the shelling operation.

## **1.2 Statement of the problem.**

Most of the hand shelled melon is time consuming. In order to meet the current high production level of melon in the country today, there is the absolute need to design a simple and inexpensive manual or mechanical shelling machine to make melon shelling very attractive and comfortable.

### **1.3. Aim and Objectives**

The aim of the study is to design and construct a simple, relatively cheaper and portable electricity operated melon shelling machine with the incorporation of separation chamber.

In other to achieve the aim the following specific objectives were pursued:

- i. Study the operating principle of already existing models.
- ii. Design an improved portable and relatively cheaper electrically shelling machine with the Incorporating of a separation chamber.
- iii. Develop a working drawing of the designed machine.
- iv. Select material for producing the component parts of the machine.
- v. Construct the different parts of the machine using locally sourced materials.
- vi. Assemble the different parts and materials together using such processes as welding soldering and the use of bolts, but and screw
- vii. Test the machine to establish it's functionality

### **1.4. Scope of study**

The scope of this project is limited to designing and fabricating a portable electrically driven melon shelling machine with the incorporation of a separation chamber. The project is limited to the design, contribution and testing of the portable melon shelling machine using an electric motor.

### **1.5. Significance of the Study**

The result of this study will be of immense benefit to melon farmers, housewives, entrepreneurs, agricultural research institutes and educational researchers. Melon farmers, traders, housewives and operators of hotels will find a cheaper, faster, energy saving and more hygienic product for

shelling and separating melon seeds. The general public will also benefit from the result of the study as the cost of shelled melon in the market would be greatly reduced through the use of the machine. Production engineering students will also benefit from the result of this study as they will learn how to design and construct melon peeling and separating machines and other similar machines. Entrepreneurs and agricultural research institutes will also find the product of this study very useful as they can use the prototype of the designed machine for mass production. Lastly, the result of this study when published will provide literature on the design and construction of melon shelling and separating machines for engineering researchers.

## **1.6 Limitations**

Some of the limitations in the course of the project include but are not limited to the following ,

- i Relatively short and condensed
- ii. ASUU strike
- iii. Insufficient funds

## **CHAPTER TWO**

### **LITERATURE REVIEW**

This chapter is a review of the literature that are pertinent to the studies carried out in this work. It also specifically considers some relevant concepts such as principle and element of design, historical development of tools and machines, types of agricultural machines, melon cultivation and processing, basic principle of operation of the melon shelling machine and theory of material separation.

#### **2.1 Principles and elements of design**

The aim of any design process is to create a product which not only works but also looks well (Lindbeck,1990). To achieve this purpose, the design process must be guided by certain principles or elements. These principles as identified by Lindbeck (1990) are grouped into three namely functional, material and visual requirements.

The principle of functionality in design demands that the product should fit the purpose or need for which it is intended (Lindbeck, 1990). This implies that a well designed article should work as it should. Lindbeck emphasized that the designer must expend a good deal of effort in ensuring the efficiency of the product he designs. He pointed out, for example, that when designing a chair, the chair must fit the human frame comfortably before it can be said to be functionally correct. Another important dimension of function in design is the durability of the product (Welch, 1998). Welch emphasized that the designer must consider the question. How long should the product function else the design will be poor. Another important consideration related to functionality is the aesthetic or form of the product. According to Welch (1998), an article may be perfectly adequate from the functional stand point but fail to be appealing to the

senses. He advised that the designer must select from a variety of possible contours (each of which may be functionality and materially correct) that form which is aesthetically most satisfactory.

## **2.2 Material requirement**

This principle, according to Lindbeck (1990) demands that the product designed should reflect a simple, direct and practical use of the substance of which it is made. In other words, the designer should achieve maximum benefit from a minimum amount of materials. He added that if this element of wise utilization is present, the structure of the product will be sound and it will be as strong as necessary without any waste of materials or excess bulk. Welch (1998) noted that the designer must have a good knowledge of the properties and limitations of several materials in order to be able to select the most appropriate ones. For instance, he must know which metals can be bent, folded, formed, soldered, welded, riveted and glued.

## **2.3 Visual requirement**

Lindbeck (1990) stated that the product should have a pleasing appearance to the beholder. He stressed that this requirement translates as a concern for the visual arrangement of the elements of design: the lines, shapes, textures and the colours. Welch (1998) noted that since human beings respond more positively to something pleasing to look at rather than an ugly object and since what one person views as beautiful may be visually unacceptable to another person, the designer must always be guided by the fact that visual requirement has to do with proper balance, correct proportion, compatible colours and textures and form.

## **2.4 Relative And Advantages Of Machines Over Human Power**

Pytlik, Lauda and Johnson (1985) posited that mechanization (the use of machines to do what human beings formerly do with their muscle power) has several advantages over the use of human power. First, machines enable human beings to perform their work easily and it also reduce considerably, the number of hours one spends working. This position is shared by Awe and Okunola (1984) who maintained that machines enable work to be easily and more quickly done. Pytlik et al (1985) also stated that the use of machines always results in large scale mass production of goods and materials. They mentioned automation (the automatic, centralized control of an integrated production system to the point where humans are no longer needed, except to watch and maintain the machines) and the assembly line as some of the features of mechanization that result in mass production of goods and which also substitute mechanical for human handling of materials.

The use of machines also lead to a rapid solution to problems that othennrise would have taken years of human effort to solve (Pytlik et all 1985). Thus, machines save human labour (Elekwa et al 1982). The application of machines in agriculture specifically results in speedy and efficient farming operations and also free man from frightfully, boring, dangerous and inhuman labours (Lindbeck, 1990). This position is shared by STAN (1991) who maintained that the use of machines in agriculture has the advantage of reducing the hard work and drudgery associated with manual farm work, reduce production costs and farm hazards and also improve the quality and quantity of agricultural produce.

## **2.5 Types of agricultural machine**

Several types of simple and sophisticated machineries are being used in agriculture nowadays.

Akinsanmi (1982) classified these machines into six groups based on their functions as follows: tillage machines, cultivating machines, fertilizing machines, spraying machines, harvesting machines and processing machines. The tillage machines or equipment are those used for land preparation and tilling. Examples include disc ploughs, harrows, ridgers, tractors, bulldozers and rolivators. STAN (1991) explained that cultivating machines or equipment are those used for planting crops. These include planters, cultivators and specialized drills used for planting different types of crops. According to Falusi and Adeleye (1998), fertilizing equipment are those specifically used for applying fertilizer to crops.

Akinsanmi (1982) noted that spraying equipment are used for spraying herbicides and other chemicals that protect crops against insect attack and diseases. Examples are dusters and sprayers. Harvesting equipment or machines are used for harvesting crops. STAN (1991) maintained that each crop has its special harvesting machine or harvester. For example, maize harvester, rice harvester, cassava harvester and combined harvesters. Processing equipment refer to those equipment or machines that are used for processing food crops. STAN (1991) listed some of the agricultural processing machines as follows:

- (a) Grinding or milling machines which grind wet or dry grains into pulp or powder.
- (b) Mixers which are commonly used in feed mills to mix feed
- (c) Shellers: These are machines used for breaking and separating seeds such as cowpeas and groundnuts from their pods.
- (d) Hullers: These are machines used for removing husk from grains such as rice.
- (e) Ginnery: These are machines or equipment used for separating cotton seeds from lint.

## **2.6 Melon cultivation and processing**

Melon whose botanical name is *Citrullus Vulgans*, according to Falusi and Adeleye (1998) is a common vegetable crop which is widely cultivated in Nigeria. Melon is also classified as a legume crop (Oni, 2005). Oni stated that it is classified as a legume crop because it has the capacity of preventing or controlling the growth of weeds on the farm. Oni also added that melon can add Nitrogen to the soil through the process of Nitrogen fixation.

Akinsanmi (1982) and Falusi and Adeleye (1998) contended that melon is propagated seed. Oni (2005) maintained that it is normally planted twice in a year - during the rainy season and during the dry season and that it is most common in Northern parts of Nigeria particularly Kano, Kaduna and Jos. After harvesting melon, the seeds are carefully removed from the pod and washed very well with water. Solar energy is then used in the conventional way to dry them (Carter, 2002). Oni (2005) reported that two (2) modern methods of drying melon have been developed. These are (a) cabinet drier and (b) rotary drier. In the cabinet drier, a metal box cabinet is constructed with tray provision. The trays are slotted into the cabinet and within intervals. Oni further explained that in the rotary system, the melon seeds are put into a round drum which is either electrically or mechanically rotated so that the dry melon seeds will be falling out. Oni advised that with whichever method, the seeds should be properly dried so as to prevent moisture formation which could damage the seeds and reduce their economic value. Oni (2005) further warned that melon seeds should never be heated directly on fire because the seed colour will turn brown and oil will be oozing out thus reducing its economic value.

## **2.7 Economic importance of melon**

Melon seeds are of great economic importance in Nigeria. They are used for soup preparation (Akinsanmi, 1982). Thus, melon seeds are the major condiments in the popular egusi soup in every part of Southern Nigeria. In other words, melon seeds are soup thickeners (Uzuegbu, 1993). Akinsanmi (1982) maintained that melon is also used for the preparation of vegetable oil. This position is shared by Uzuegbu (1993) and Oni (2005). In further support of this fact, Falusi and Adeleye (1998) stated that melon seeds contain about 45% oil. Melon is also used for the preparation of melon cake which serve as livestock feed as well as food for man (Akinsanmi, 1982). Moreover, melon seeds are now exported (Oni, 2005). Oni noted that the seeds can be exported either shelled or unshelled and that they are packaged in bags of 25kg or 50kg.

## **2.8 Basic principles of operation of the melon shelling machine**

The melon shelling machine converts electrical energy supplied to it into mechanical energy which is used to peel the melon seeds. It has an electric motor which utilizes electrical energy to produce mechanical energy required for peeling. The machine therefore works on the principle of electromagnetism. In other words, it is the process where electric current is produced as a result of moving conductors through magnetic fields (Awe and Okunola, 1984). For a better understanding of the principle of electromagnetism, it is expedient to have an insight of the construction and working principles of an electric motor.

According to Williams (2002), an electric motor is a device for transforming electrical energy into mechanical energy. Nice (2001) noted that its operation is based on simple electromagnetism. That is, when a current carrying conductor generates a magnetic field and is then placed in an external magnetic field, it will experience a force proportional to the current in

the conductor and to the strength of the external magnetic field. He further explained that the internal configuration of the electric motor therefore harness the magnetic interaction between the current - carrying conductor and the external magnetic field to generate rotational motion. In other words, electric motors contain a wire coil in a magnetic field (Williams, 2002). These coils, according to Bamiro et al (1986) are called armature in dc motors or rotors in ac motors. They explained that when electrical energy is fed into the set of coils, the current will produce a magnetic field like an electro-magnet. This field opposes that of a surrounding electro-magnet resulting in the rotation of the armature or rotor. Thus, the electric motor converts the electrical energy supplied to it unto mechanical energy of the rotating armature or coil.

## **2.9 Types of electric motor**

Schwaller (1980) maintained that electric motors are classified according to the type of current used to operate them. Thus, there are basically two basic kinds of electric motors - Direct current (Dc) motor and Alternating current (Ac) motors. Irvin (1992) noted that a wide variety exists among the two groups. Dc motors as the name implies, operate on direct current. Irvin (1992) stated that it is the oldest type of motor but it is used infrequently today because alternating current is more commonly available. He explained that this stems from the fact that direct current cannot be transmitted over long distances as high voltage alternating current can be. Irvin further stated that because of the limited demand, dc motors are very expensive and often hard to obtain. Moreover, they do not hold a constant speed as ac motors, they cause radio and television interference and they require regular maintenance of commutator and brushes. Furthermore, they are larger than the more common ac motors of the same horsepower rating.

Ac motors on the other hand, are operated with alternating current. An alternating current is current that reverses its direction at regular intervals. That is, the power fluctuates (at a fast rate) causing an instant peak of power followed by an instant loss of power (Irvin, 1992). Alternating current can be of single phase, or three phases. Thus, there are single phase ac motors and three phase ac motors. Which operate on single phase and three phase alternating current respectively (Schwaller, 1980). Schwaller explained that in a single phase ac motor, there is a momentary loss of power when the voltage changes polarity and the current 3. The capacitor start - induction - run motors which uses a condenser connected in series with a starting winding, has a high starting torque and a high breakdown torque. Schwaller (1980) noted that a dc motor can also operate on alternating current if the ac is adapted to dc. Likewise, an ac motor can also be operated with direct current if the dc is converted to ac through the use of a power inverter. However, there are electric motors that could run on both direct current and alternating current. These motors, according to Irvin (1992) are called universal ac/dc motors. Universal motors are used for stationary equipment accessories like a knife grinding attachment, a vacuum cleaner type of dust collectors and in portable electric tools.

The internal construction of dc and ac motors are basically the same except for a few differences. Nice (2001) stated that every Dc motor has six basic parts namely the axle, rotor (or armature), stator, commutator, field magnet(s) and brushes. The stator is the stationary part of the motor - this includes the motor casing as we know as two or more permanent magnet pole pieces. The armature together with the attached commutator rotate with respect to the stator. The rotor consists of windings (generally on a core), which are electrically connected to the commutator. Nice (2001) further explained that the arrangement of the brushes, commutator contacts and rotor windings are .in such a way that when power is applied, the polarities of the energized winding

and the stator magnet(s) are misaligned and the rotor will rotate until it is almost aligned with the stator

1. The repulsion start - induction - run motors which has no switch nor capacitor but uses a lever to reverse the motor.
2. The split - phase - induction - run motors which have both a starting winding and a running winding and are the least expensive of the three types of single phase motors.
3. The capacitor start - induction - run motors which uses a condenser connected in series with a starting winding, has a high starting torque and a high breakdown torque.

Schwaller (1980) noted that a dc motor can also operate on alternating current if the ac is adapted to dc. Likewise, an ac motor can also be operated with direct current if the dc is converted to ac through the use of a power inverter. However, there are electric motors that could run on both direct current and alternating current. These motors, according to Irvin (1992) are called universal ac/dc motors. Universal motors are used for stationery equipment accessories like a knife grinding attachment, a vacuum cleaner type of dust collectors and in portable electric tools.

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and the stator magnet(s) are misaligned and the rotor will rotate until it is almost aligned with the stator field magnets. As the rotor reaches alignment, the brushes move to the next commutator contacts and energize the next winding. Thus, in a three pole Dc motor, one pole is fully energized at a time while the other two are 'partially' energized. As each brush transitions from one commutator contact to the next, one coil field will rapidly collapse as the next coil's field will rapidly charge up. This occurs within a few microseconds. Nice concluded that the rotation of the rotor reverses the direction of current through the rotor winding leading to a 'flip' of the rotor's magnetic field, driving it to continue rotating.

According to Schwaller (1980) the ac motor is basically a transformer in which a voltage and current in one coil called the primary another voltage and current in a nearby coil called the secondary. As with a transformer, the following relationship exists between the primary and secondary coils.

Schwaller added that in the ac motor, the primary coil which is called the stator is stationary while the secondary coil which is known as the rotor is free to move. He further added that three principal parts make up the stator: an outlet frame, a steel core and the windings. The frame supports the stator core which is mounted on the motor base. The stator core contains the stator windings and are fitted inside the stator frame

Irvin (1992) explained that when the stator windings are energized by ac voltage, it create a magnetic field inside the rotor. He maintained that the rotor has three main parts: a core, windings and a shaft. The rotor core is made of many round, flat, steel punchings which are stalked together for mechanical strength. Metal or wire windings are inserted into holes in these punchings to make up the rotor windings or bars.

## **2.10 Theory of material separation**

According to Holderness and Lambert (1982), our environment is filled with mixtures of all forms of matter hence men has always been, and still is, pre-occupied with the separation and purification of useful components from each mixture for his own benefit. They defined a mixture as a substance which contains two or more substances physically combined together. They further stated that mixtures of substances can be separated by physical means and that there are a great variety of physical methods used to separate a wide variety of mixtures. In addition, they maintained that the particular method employed for any given mixture depends upon the nature of the constituents such as the relative sizes and shape of the constituents, the weight, boiling point, melting point and density of the constituents. This position is shared by Henderson and Perry (1981) who stated that the choice of a separation method depends on the size, shape, specific gravity and surface characteristics of the materials.

Henderson and Perry (1981) identified four common methods used for separating a mixture of grainseeds from their shells or husks. These are: handpicking, sieving, inclined surface and blowing. By the hand picking method, the components that are bigger in size are first handpicked leaving the ones that are smaller in size. For example, a mixture of maize and sand, rice and beans, palm kernels and its shells, beans and its shells, etc. This method can also be used for separating melon seeds from its shells after shelling. This sieving method involve pouring the mixture on a sieve and shaking it so that the constituent that is smaller in size will pass through the sieve leaving the other constituent on top of the sieve. Sieving can be used to separate a mixture of rice and sand, beans and rice, oil palm fruit and its husks, etc.

The inclined table method, according to Henderson and Perry (1981), involves the pouring of the mixture on an inclined surface so that the seeds will roll down leaving the husks, shells or debris on the upper part of the inclined surface. This method is mostly used for separating seeds that are

round or oval in shape from their shells. For example, it is widely used for separating palm kernels seeds from its shells and oil palm fruits from its husks or debris. The last method, blowing involves blowing the mixture either by mouth or through a mechanical or electrical method so that the lighter constituent in the mixture will be blown off leaving the other constituent behind. This method is very good in separating melon seeds from its shells as well as for separating rice from its husks

### **2.11 Review of related empirical studies**

It was not possible to find literature on the design and construction of the melon peeling and separating machine. Therefore, review of literature on the design and construction of other mechanically and electrically operated agricultural processing machines was done. Obasi (2004) while working on the design and construction of palm kernels and shells separator for developing countries was able to design and construct a mechanically operated machine capable of separating palm kernel seeds from its shells after grinding. The machine was designed and constructed for the Department of production engineering, University of Benin Uniben.

Akintunde (2005) worked on the design and construction of palm fruit digester for palm oil production in Osun State of Nigeria. Akintunde was able to design and construct an electrically operated. Palm fruit digester which could pound oil palm fruits for the oil palm farmers in Osun State of Nigeria. The design and construction of the machine was done at the Department of production engineering, University of Benin Uniben. .

### **2.12 Summary of review literature**

The literature reviewed has revealed that from time immemorial, man has always designed and constructed tools and machine in response to his needs and that design changes as man's

technical knowledge, material requirement and aesthetics requirement changes. It has also been found that the use of machines can improve agricultural productivity. The review has also revealed that there are several types of agricultural processing machines which have been designed and constructed for the processing of most of the crops cultivated in Nigeria.

Literature revealed that most electrically operated agricultural processing machines which have electric motors convert electrical energy into mechanical energy. Thus, they work on the principle of electromagnetic induction. However, empirical studies on the design and construction of melon shelling and separating machines. Therefore, empirical studies on the design and construction of other manually and electrically operated agricultural processing equipment were made. This study therefore intends to bridge the gap by focusing on the design and construction of an electrically operated melon shelling and separating machine

## **CHAPTER THREE**

### **METHODOLOGY**

This chapter describes in details the design considerations, analysis, choice of materials, construction, operation and the experimental procedure required to develop and test melon shelling machine.

#### **3.1 Method of research**

1. Literature review on the subject area through the use of journals, past project, the internet and textbooks
2. Selection of material for the project based on suitability of the material, mechanical properties, their resistance to corrosion and availability in the local market
3. Market survey
4. The construction and testing will involve appropriate machine processes and procedures such as measuring, cutting, welding, grinding etc.

#### **3.2 Description of the motorized operated melon shelling**

The machine is made up of the following main components.

- i. The hopper
- ii. The shelling chamber
- iii. The electric motor and
- iv. The supporting base

v. Blower

A description of various component parts were made with materials used as stated below

### **3.2.1 Fabrication of the Hopper**

The hopper opens directly into the shelling unit through a centralized hole. The hopper is meant to receive the melon seeds before they are eventually moved into the shelling chamber. The hopper is made up of four welded mild steel metal sheet slanting toward the smaller opening. The mild steel metal sheet was marked out with the aid of set square, steel rule and scribe. An allowance of 10mm was given on all edges of the sheet to cater for hemming. Cutting was done with a shearing machine, chisel and hammer. The cut out sheet was later folded and thereafter welded using manual arc welding machine.



**Figure 3.1: The hopper**

### 3.2.2. Fabrication Of The Shelling Chamber

The shelling chamber consists of the shelling drum, the shelling vanes and shelling disc. The shelling drum was made from mild steel and the inner part of the drum is lined with 1/4 inch rods.. The shelling disc was made from mild steel and has vanes slots at the edges. The shelling vanes are made from mild steel. The shelling chamber incorporates an opening at the bottom part which serves as an outlet for the shelled melon seeds.



**Figure 3.2: Inner Drum**

### 3.2.3 Electric Motor

The electric motor is used to transmit power or rotational motion to the shelling disc through its protruding shaft with the aid of a key that fastened them together. The power rating of the electric motor is 1hp. The electric motor was bought already made from the market.



**Figure. 3.3 Electric motor**

### **3.2.4 Fabrication of the Frame And Supporting Base**

The frame is the structure that holds all the components together. It was constructed with 25mm square hollow pipe with 2mm thickness and metal plate of 450mm by 375mm with 3mm thickness. The metal plate was welded to the frame after measurement and cutting it to size. The base is the structure that supports the electric motor and the shelling chamber to the frame. The base was constructed with flat bars of 35.5mm with 3mm thickness. 12mm rods of different length were used to braze the shelling drum and the electric motor to the frame to reduce vibration and enhance



**Figure 3.4: Supporting base**

### **3.2.5 Assembling of Parts**

After all the components have been fabricated, the following steps were taken to assemble the machine. The electric motor with a protruding shaft at one end was installed on the base made with 35.5mm flat bar and supported with 25mm square hollow pipe held together with a clamp. The next step was to fix the shelling drum on the base. The shelling drum was held or supported with a 25mm square pipe welded to both the shelling drum and the base. The shelling drum houses the shelling disc which is fastened to the shaft protruding from the electric motor. Using manually operated arc welding machine, the hopper was welded to the shelling pot in such a manner that permits smooth flow of unshelled melon seeds into the shelling chamber.



**Figure 3.5: Assembling parts**

### **3.3 Design Calculations**

Important and essential mathematical, mechanical and other engineering materials were consulted in the design of all parts needed for the fabrication of the melon shelling machine.

Coefficient of friction of pulley,  $\mu = 0.3$

Density of rubber belt,  $\rho = 1140 \text{ kg/m}^3$

Pie,  $\pi = 3.1242$

Acceleration due to gravity  $g = 10 \text{ m/s}^2$

$0.5 \text{ hp} = 746 \text{ w}$

Hopper Capacity: The cross sectional area of the hopper is more like the frustum of a pyramid

According to Moise (1967)

Volume of the frustum of the pyramid

$$v = \frac{1}{3}h(B + B_s + \sqrt{B + B_s}) \quad (1)$$

Where:  $B = \text{Area of large base} = \text{mm}^2$  :  $B_s = \text{Area of small base} = \text{mm}^2$  :  $H = \text{Altitude of the frustum} = 150 \text{ mm}$

$$\therefore v = 15.15 \times 10^3 \text{ mm}^3$$

Velocity of Pulley

$$N_1 D_1 = N_2 D_2 \quad (2)$$

Known that  $N_1 = 1400 \text{ rpm}$ ,  $D_1 = 0.1397 \text{ m}$ ,

$$D_2 = 0.1651 \text{ m}. N_2 = ?, 1400 \times 0.1397 = N_2 \times 0.1651$$

Therefore,  $N_2 = 1184.615 \text{ rpm}$

Number of revolution of the driven pulley is

1184.615 rpm

Torque Transmitted By Electric Motor ( $T_s$ ): The

machine is design with 1hp electric motor

$$1\text{hp} = 0.7\text{kw}$$

Number of revolution = 1400 rpm

$$T_s = \frac{p}{\omega} \quad (3)$$

Where: P = power of electric motor; = Angular speed

of electric motor

Known that

$$\omega = 2\pi N/60 \quad (4)$$

$$= 146.61\text{rad/sec}$$

Therefore  $T_s = 746/146.61$

$$= 5.09\text{Nm}$$

$$T_s = (T_1 - T_2) r_1 \quad (5)$$

Where r = radius of small driving pulley

$$\text{Therefore, } 4.92 = (T_1 - T_2)0.06985$$

$$T_1 - T_2 = 136.6929\text{N} \quad (6)$$

Belt Speed

$$V = \omega r_1 \quad (7)$$

Where, V= peripheral velocity of the belt,  $\omega$ = Angular

velocity=146.61rad/sec

V= m/s

Length of belt

$$L = \frac{\pi}{2(r_1+r_2)} + 2x + \frac{(d_1-d_2)}{4x} \quad (8)$$

The center distance between the driving and driven

pulley is given as

$$x = \left(\frac{r_1}{2} + \frac{r_2}{2}\right) r_1 \quad (9)$$

$x = 0.02129$  m

Therefore,  $L = 0.528997\text{m} = 528.997\text{mm}$

Wrap Angle ( $\alpha$ ): To find the angle of contact of both

pulleys,

$$s\alpha = \frac{r_2-r_1}{x} \quad (10)$$

$\alpha = 36.620$

Area of Belt (A)

$$A = \frac{a+b}{2} \quad (11)$$

Where:  $a=3.3\text{mm}$ ,  $b=16.23\text{mm}$  and  $h= 8.7\text{mm}$

$$A = 85.086\text{mm}^2 = 85.086 \times 10^{-6}\text{m}^2$$

Mass Of Belt (M): Mass of belt per meter length

$$M = A \times L \times \rho \quad (12)$$

Mass = area of belt x length of belt x density of belt

Where: density of rubber belt is  $1140\text{kg/m}^3$

$$= 85.086 \times 10^{-6} \times 0.528991 \times 1140$$

$$M = 0.0513\text{kg}$$

Tension on Belt: From the dimension of a standard V-grooved pulley

$$T_1 = T - T_c \quad (13)$$

Where,  $T_1$  = Tension on tight side,  $T_c$  = Centrifugal tension

$$T_c = Mv^2 \quad (14)$$

$$= 0.0513 \times 10.24192$$

$$= 5.38\text{N}$$

$$\frac{T_1 - T_c}{T_2 - T_c} = \frac{r_1 \alpha_1}{e^{\sin \theta / 2}} \quad (15)$$

$$T_1 = 1.17612 \quad T_2 = 0.9229$$

Known that

$$T_1 - T_2 = 136.6929\text{N}$$

Then  $T_1 = 73.45\text{N}$ ,  $T_2 = 63.24\text{N}$

Power transmitted by the belt

$$P = (T_1 - T_2)V \quad (16)$$

$$= (136.6929) \times 10.2419$$

$$= 1399.995\text{W} = 1.9\text{Hp}$$

$$\text{Torque, } T = \frac{60p}{2\pi N} \quad (17)$$

Where power = 746w

$$T = 6.0128\text{Nm}$$

$$\text{Bending moment } M = (T_1 + T_2 + 2T_c) \quad (18)$$

$$= 147.45\text{Nm}$$

$$T_e (\text{Equivalent twisting moment}) = \sqrt{T_2^2 + M_2^2} =$$

$$147.573\text{Nm}$$

### 3.4. Steps Involved in the Design and Construction of a Machine

According to Bamiro, Nurudeen and Akuru(1986), three basic steps are involved in the design and construction of a machine, and they are;

(i) the design stage

(ii) the working drawing stage and

(iii) the fabrication or construction stage.

They explained that the design stage is the decision making stage .It is at this stage that the following important decisions will be taken

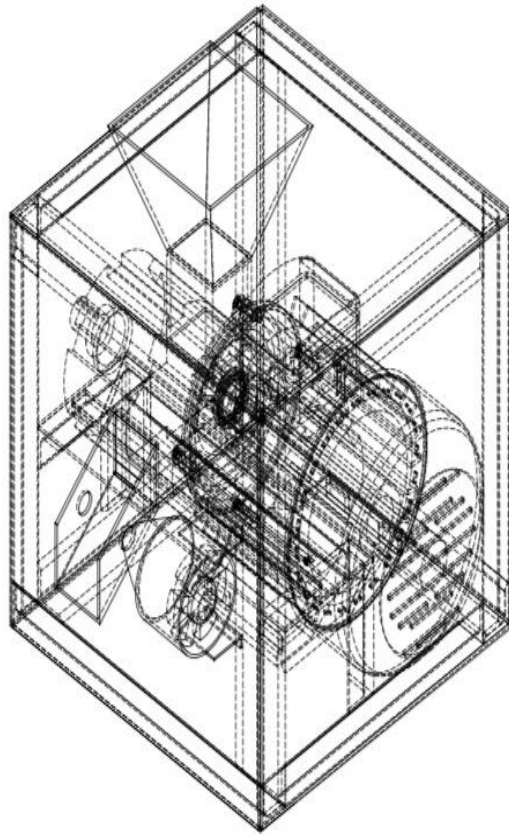
- i. the size of the project
- ii. the suitability of the project for the intended purpose
- iii. the type of material that will be used
- iv. the cost of the materials that will be used
- v. the pattern, style or design that will be adopted
- vi. the relatives size of sections
- vii. the type of joints rushed to enable it withstand necessary handling
- viii. the type of finish that will give to the product
- ix. the total cost of the project

### **3.5. Cost Analysis**

#### **Bill of Engineering Measurement and Evaluation**

<b>COMPONENTS</b>	<b>SPECIFICATION</b>	<b>AMOUNT</b>
Motor	13 watts	N60,000
Mild Steel	6yards	N50,000
Shelling Disk	1	N8,000
4 yard wire	Flex	N4, 000





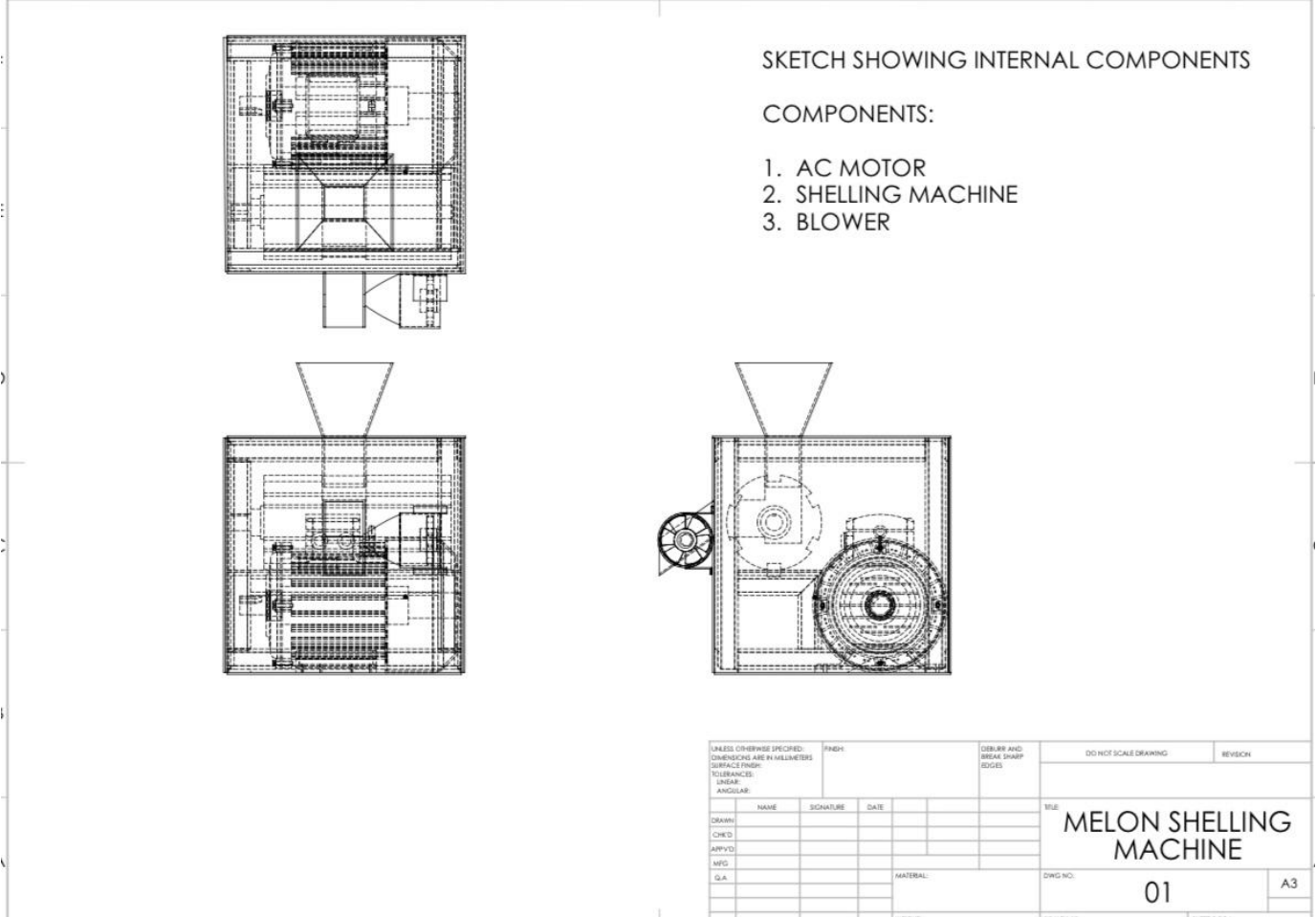
SKETCH SHOWING INTERNAL COMPONENTS

COMPONENTS:

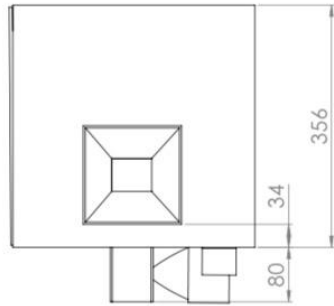
1. AC MOTOR
2. SHELLING MACHINE
3. BLOWER

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:		FINISH	DEBURR AND BREAK SHARP EDGES		DO NOT SCALE DRAWING	REVISION
DESIGN	NAME	SIGNATURE	DATE		TITLE: <b>MELON SHELLING MACHINE</b>	
CHECKED					DWG NO.	A3
APPROVED					01	
MFG				MATERIAL:		
QA						
				ISSUED	10/21/15	ISSUED 1/15/16

**Figure 3.6: Internal Components**

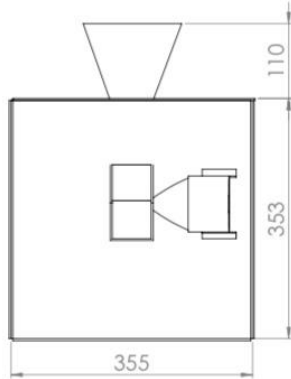


**Figure. 3.7: Internal Components Orthographic View**

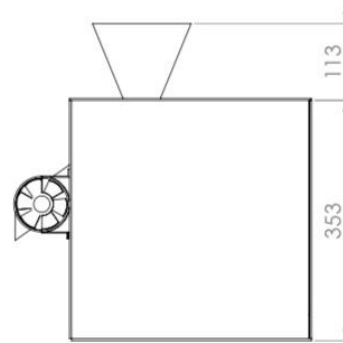


**PLAN VIEW**

**MATERIAL: MILD STEEL**



**FRONT VIEW**

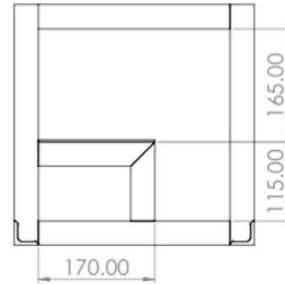
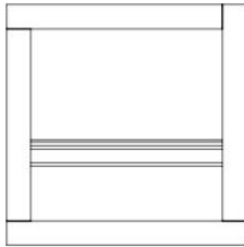
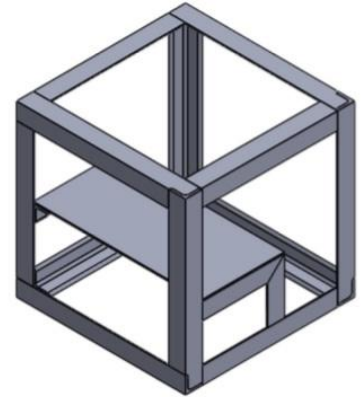


**SIDE VIEW**

UNLESS OTHERWISE SPECIFIED: (DIMENSIONS ARE IN MILLIMETERS)		FINISH:	DIBLIND AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:				TITLE	
DRAWN:	NAME	SIGNATURE	DATE	<b>MELON SHELLING MACHINE</b>	
CHK'D:					
APP'VD:					
MFG:					
Q.A:					
MATERIAL:			DWG NO.:	01	A3
WEIGHT:			SCALE: 1:10	SHEET 4 OF 4	

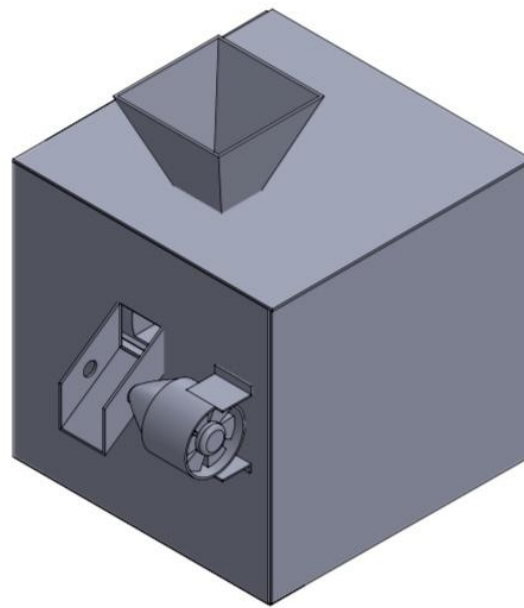
**Figure 3.8: Orthographic view**

# MACHINE SUPPORT FRAME



UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: LINEAR: ANGULAR:			FINISH	DEBURY AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
DESIGN	NAME	SIGNATURE	DATE		TITLE: MELON SHELLING MACHINE	
CHECK					DWG. NO. 01	A3
APPROV.					SCALE: 1:1	SHEET 4 OF 6
MFG.				MATERIAL:		
QA				WEIGHT:		

Figure 3.9: Supporting Frame



UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS		FINISH:		DEBURR AND BREAK SHARP EDGES		DO NOT SCALE DRAWING		REVISION	
SURFACE FINISH: TOLERANCES: LINEAR ANGULAR:									
DRAWN:	NAME	SIGNATURE	DATE			TITLE: <b>MELON SHELLING MACHINE</b>			
CHK'D:									
APP'D:									
MFG:									
Q.A.					MATERIAL:	DWG NO.		01	
								A3	

**Figure 3.10: View of Melon Shelling Machine**

## CHAPTER FOUR

### RESULTS AND DISCUSSION

#### 4.1 Calculation for Shelling Efficiency for Seed Type A Using Various Feed Rates (Kg/hr)

$$\frac{W_{sb}-W_{su}}{W_t} \times 100\%$$

Where  $W_{sb}$  is the number of broken seeds that were shelled(broken),  $W_{su}$  is the number of unbroken melon seeds that were shelled,  $W_t$  is the total number of melon seeds

##### First Sample using feed rates of 6.85kg/hr

$$\frac{35-10}{45} \times 100\% = 56\%$$

##### Second Sample using feed rates of 11.85kg/hr

$$\frac{34-6}{40} \times 100\% = 60\%$$

##### Third Sample using feed rates of 13.00kg/hr

$$\frac{50-20}{70} \times 100\% = 43\%$$

##### Fourth Sample using feed rates of 18.50kg/hr

$$\frac{32-8}{40} \times 100\% = 58\%$$

Average Shelling Efficiency for type A seed:  $\frac{56+60+43+56}{4} = 53.75\%$

Average Shelling Efficiency for type A seed: = 53.75%

**Calculation for Shelling Efficiency for Seed Type B Using Various Feed Rates (Kg/hr)**  
**First Sample using feed rates of 12.20kg/hr**

$$\frac{36-14}{50} \times 100\% = 44\%$$

**Second Sample using feed rates of 13.30kg/hr**

$$\frac{36-16}{52} \times 100\% = 38\%$$

**Third Sample using feed rates of 21.75kg/hr**

$$\frac{35-16}{51} \times 100\% = 37\%$$

**Fourth Sample using feed rates of 27.30kg/hr**

$$\frac{33-18}{51} \times 100\% = 29\%$$

**Average Shelling Efficiency for type B seed:**  $\frac{44+38+37+29}{4} = 37\%$

**Average Shelling Efficiency= 37%**

#### **4.2 Machine Performance Evaluation**

Performance measures were made for three measures which have already been mentioned in the foregoing, are the shelling efficiency, the likelihood of damaging seeds and the critical spreading time. These will be discussed in the following order.

**Table 4.1: Values of Feed Rates and Efficiency for Seed Type A(Yellow Seed)**

Feed Rates (kg/hr)	Efficiency (%)
6.85	56
11.85	60
13.00	43
18.50	58

**Table 4.2: Values of Feed Rates and Efficiency for Seed Type B(White Seed)**

Feed Rates (kg/hr)	Efficiency (%)
12.20	44
13.30	38
21.75	37
27.30	29

### **4.3. Likelihood of Damaging Shells**

A similar measure is made of the number of damaged seeds (Shittu and Ndrika, 2012) which is:

$$b = \frac{W_{sb} + W_{ub}}{W_t} \times 100\%$$

Where  $s_b$  is the percentage of seeds which are broken,  $W_{ub}$  is the number of broken unshelled seeds,  $W_{sb}$  is the number of broken seeds that were shelled (broken), and  $W_t$  the total number of seeds.

#### **4.4. Critical Spreading Time**

A third performance metric is the critical spreading time. This time is related to a water-soaking process which is needed in order to sufficiently soften the shells. Water is applied in sufficient amounts to thoroughly moisten the shells. The seeds are then allowed time to "ptake the water into the shell. This uptake duration is the Critical Spreading Time.

**Note:** Assumptions were made for feed rates to test for different levels of efficiencies using the two specimens of melon seeds which are White and Yellow seeds types of seeds. The results of the various efficiencies shown, were calculated in the preceding page.

#### **4.5. Discussion**

After fabrication, the melon shelling machine was operated to determine the optimum shelling parameters for the machine.

The materials

The materials/equipment to be used in conducting the experiment are;

- i. Weighing balance
- ii. Melon
- iii. The fabricated Melon shelling machine
- iv. The melon collector

#### **4.6. Test procedures**

The machine consists of a feed hopper, a shelling unit, a delivery chute, a power system and a tool frame. The shelling action was achieved by principle of a rotor that throws melon seeds against the shelling drum by centrifugal force and then the seeds were converged onto a spinning disc with vanes that provide impact force to remove the kernel from the shell. The results of the performance tests carried out showed that the machine shelling efficiency increased with the increase in moisture content and speed. Average shelling efficiency percentage of 53.75% was obtained at the seed moisture content of 26.6% d.b and at 1500 rpm shelling speed.

## **CHAPTER FIVE**

### **CONCLUSION AND RECOMMENDATION**

#### **5.1 CONCLUSION**

The design of the melon shelling was carried out and the machine was successfully constructed, assembled and tested. Conclusively, this project work was aimed at designing and fabricating a portable melon shelling machine comprising of a shelling and separation chamber specifically for domestic use. This was done with a view to ease the processing of melon seeds which basically involves shelling. In a bid to achieve this aim, some laid out objectives were followed and they include studying the parameters and mode of operation of already existing melon shelling machine which served as a precursor for mapping out a design for an electrically operated machine capable of both shelling and separating already shelled melon seeds. Further more on the list of objectives is the construction of the different parts of the machine using locally sourced materials, especially sheet metal and purchasing the needed components like a single phase A.C. motor, blower and switch amongst others. This was followed with the assembly of already sourced parts and materials using different joining processes like welding, soldering and the use of bolts, nuts and screws. The last part of the objective set out to achieving the aforementioned aim, is the testing of the fabricated machine to ascertain its functionality.

## **5.2. RECOMMENDATION**

With the performance results presented so far, and with an analysis of the components of the machine, it is possible to make design recommendations for a next-generation prototype. Some of these suggestions are geared to provide optimal performance whereas others are suggested to lower initial costs of the machine.

It was discovered that the power produced by the motor was in excess of that necessary for the shelling operation. As a result, excess energy was used and electro-mechanical efficiency was reduced. Consequently, next generation prototypes should be designed with a lesser hp motor instead of the current 0.5hp.

Next, It was also found that the presently designed machine is subject to vibration during its operation. To reduce vibration and the likelihood of machine failure, it is recommended that a wider base footprint be used with polymeric dampening pads. Also a dampening on the motor casing should be considered.

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