DESIGN AND FABRICATION OF A MANUAL HYDRAULIC PRESS FOR CASSAVA MASH DEWATERING

BY

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2003/14783EA

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MINNA.

NOVEMBER, 2008

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A project Submitted To The Department Of Agricultural And Bio-Resources Engineering, School Of Engineering And Engineering Technology, Federal University Of Technology,

Minna.

NOVEMBER, 2008

DEDICATION

This project is dedicated to the Almighty God and to his servant, Bishop David Abioye.

DECLARATION

I, hereby declare that this Project is record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any University of institution. Information derived from personal communications, published and unpublished works of others were duly referenced in the text.

ATULUKU OBED OJONIMI 18/11/08

(Name of student) Date and Signature

CERTIFICATION

This project entitled "Design and Fabrication of a Manual Hydraulic Press for De-watering of Cassava Mash in five minutes" by Atuluku Obed Ojonimi meets the regulation governing the award of the degree of Bachelor of Engineering (B.ENG) of the Federal University of Technology Minna, and it is approved for its contribution to scientific knowledge and literary presentation.

Professor E.A.S. Ajisegiri ....

Supervisor Date

r. Z Osunde 26/11/2008

ad, Department of Agricultural Date

gineering

.... 18/11

rnal Examiner Date

ACKNOWLEDGEMENT

Thank you everlasting father, the Almighty God, for giving me the strength, courage and for ordering my steps, during my stay in this university.

I want to extend my profound gratitude to my able supervisor, Prof. E.S.A Ajisegiri for his support and encouragement. Thank you very much sir.

I am equally indebted to my H.O.D Dr Z. Osunde, not forgetting my level adviser, Engr. Peter Adeoye and all other lecturers, for their academic knowledge they have imparted on me, in cause of my study, am grateful to you all.

My special thanks goes to my parents Engr. & Mrs Peter Atuluku, who has being an epitome of good moral in my upbringing, it's no soothsaying that you are one in a million, am grateful to God for having you as my parents. To my siblings Idoko, Mary, Lois and David thank you so much for being there. I love you all.

My special thanks also go to my Grandmother; Mama Laruba Atuluku (Mama Agodo) and my grandparents Pa & Mrs. Oguh, Alhassan. My gratitude also goes to the entire family of Mr & Mrs Paul Audu, Mr Mathew Atuluku, Pastor & Mrs John Opaluwa and Pastor and Mrs Ohere. Thanks to all my friends Dipo, Deola, Josibe, Arike, Mathew Amana, Mathew Egene, Idoko Attah, Jude, Bidexy, Lanre, Abraham amongst others and to my very good friend Abigail Odiba, thanks for all your support, we will all meet at the top, where the eagles fly. And finally to the entire Atulukus, Alhassans, my extended family, and to all those who has been of help in cause of this work, I love you all

TABLE OF CONTENT

Chapter two

LIST OF TABLES

LIST OF FIGURE

CHAPTER ONE

1.0 INTRODUCTION

Food is a basic necessity of life, all living organism need food to survive. Human being take in various types if food that provide their body with all the basic nutrient it needs for growth such food can be classified into the following groups or classes. They include protein food, carbohydrate food, fats and oil and vitamins giving food.

Proteins foods such as fish, meat, egg, milk e.t.c. are needed by the human body for the building of body cells, the repair and replacement of body tissues. Vitamin giving food is needed by the body to build immune system for the body against disease and antibodies.

They are responsible for fast recuperation and clothing on fresh wounds or cuts. Such foods include the followings fruits such as pawpaw, oranges, garden eggs, mangoes e.t.c. Carbohydrates foods are generally energy giving food and the end product of carbohydrate after digestion in the human body is glucose. This glucose is the main source of t strength for the cells; hence it keeps the body strong. Carbohydrate food constitutes a large percentage of the daily diet consumed by a lot of people. This can be attributed to its relative availability and cheap price. Hence in Africa, one of the most widely eaten of carbohydrates food is cassava.

This is a tropical tuber plant that can be processed into different edible food such as garri, fufu, kokoro, tribisco, cassava cake, lafun, yawaska and starch. Cassava can also be boiled and eaten with palm oil or groundnut oil, spices or stew. For cassava to be processed into other food products it in most cases undergoes the process of grating, this is the grinding of cassava and dewatering. After peeling of the cassava, it is grated and then dewatered through the use of certain devises.

The dewatering of cassava is a very important process which facilitates the processing of cassava into other by-products. There are different methods of dewatering cassava mash, some of which include the following;

1. Using stone as a press
2. Using wooden planks and rope
3. Using vice and drift
4. Using hydraulics press

1.1 THE DIFFERENT METHODS OF DEWATERING CASSAVA

1.1.1 USING STONE AS A PRESS

This is by far the most common and widely used methods of dewatering cassava mash. In this method, the cassava mash is placed into a strong sack and the mouth of the sack is strongly tied together. The sack is then lifted and placed into a stone slab. A very heavy stone is lifted and placed on the sack. The heavy stone hereby acts as the press. Sometimes the stone slab is placed inside a very big round basin. This is usually done in the case where the drained fluid is needed for further use. The stone slab in the basin serves as a press as well as a partition to create a lifting up for the sack and its content from coming in contact with the drained fluid. The heavy stone placed on the sack is allowed on it for at least (12 hours) after which it is lifted off the sack and then the dewatered cassava mash is taken for onward processing.

Limitation: This method does not provide enough press force to thoroughly dewater the cassava mash. Also the cassava mash is not uniformly dewatered because of the contact area of the heavy stone.

This method is also not hygienic because of the fact that it is left open for too long and contamination can easily take place also the drained fluid which are processed into other edible food products all gather round the stone slab.

1.1.2 USING VICE AND DRIFT

This method involves the use of a power screw with a turning arm on top of it. It is constructed with two-frame support and the power screw is located in between them. A press plate is welded to the end of the power screw (at the bottom side). This dewatering device uses the principle of the normal jerk for its operation. A big nut is welded to a frame that crosses the two body frame at the top end. The power screw passes through this nut and goes up and down relative to the direction of turning the long arm of the power screw. The cassava mash is placed on top of a plate between the body frame of the device. With the turning of the power screw in the clockwise direction, the press plate at the bottom end of power screw travels down and therefore presses the sack against the bottom plate and thereby dewatering the cassava mash contained in the sack.

Limitation: This method is labour consuming and time wasting.

1.1.3 USING WOODEN PLANKS AND ROPE

In this method, the cassava mash is packed into a strong sack and tied properly. It is then lifted on top of a big wooden plank. Another heavy plank is placed on the sack, then a very strong rope is tightly wind around the two planks, which in turn acts as a press to dewater the cassava mash in the sack. At space of approximately 3 hours the rope is re-tighten with increased tension, the tighter the rope is the more the pressing force acts on the planks with the sack in between them.

Limitation: This method is not very efficient because it is labour consuming and the cassava mash is not usually properly dewatered.

1.2 MODIFICATION ON THE EXISTING HYDRAULIC JACK

All of the explained methods are basically labour consuming and time wasting. This is one of the basic reasons for this project which is the design and fabrication of a manually hydraulic jack for timed dewatering of cassava mash.

The device is basically made up of the following parts

(1). Hydraulic jack

(2). Turning handle

(3). Lever

(4). Tank

(5). Collector tank

(6). Liquid drain

(7). Disc plate

The dewatering of the cassava mash through the use of the manually hydraulic cassava dewatering device has greatly reduced the over fermentation that takes place when the cassava mash stays too long in the dewatering process. This problem is often encountered through the use of other means of dewatering cassava mash, such as the use of vice and drift, wooden planks and ropes and through the use of stone as a press. The device can be one-man operated and require very simple operation procedure. Apart from the ease of operation, it is also easy to maintain. The purpose of introducing this hydraulic system is to reduce effort put in pressing the cassava mash and this gives better efficiency. The device is also time saving when compared to the other means of dewatering cassava mash. The hydraulic jack position of the device is to enable the fluid dewatered from the cassava mash collect easily at a point and hence prevent splashing of the fluid around the floor where the device is placed.

1.3 OPERATION OF A HYDRAULIC PRESS

A hydraulic press is a hydraulic mechanism for applying a large lifting or compressive force. It is the hydraulic equivalent of a mechanical lever, and is also known as a Branch Press after the inventor Joseph Bramah press are the most commonly used and efficient form of modern press. The effective operation of a hydraulic jack under normal adjustment and condition involves the following:

(1). The pressure at any point in a static liquid is the same in every direction and exerts equal forces in equal area.

(2). The pressure exerted by a liquid at rest is always at right angle to the surface of the container (vessel).

(3). The pressure exerted by a liquid in a closed container e.g. tank is equally transmitted in all directions throughout the container.

(4). The pressure exerted by the fluid is a function of the fluid density.

It is on these four operation fundamentals that the design and fabrication of a manually hydraulic jack was based. It should also be noted that it is related to other constraint such as stress, buckling, loading and general stability especially at ultimate load are adequately considered.

1.4 OBJECTIVE

This project is aimed at designing and construction of manually operated hydraulic cassava dewatering press that can be used by rural dwellers and small scale cassava processing plant. This manually operated hydraulic cassava dewatering press has been designed to extract the liquid content of the cassava. This is considered in view of the need for a quicker processing time as compared to the local existing method of dewatering cassava.

1.5 SCOPE

The project (manually operated hydraulic cassava dewatering press) was designed to apply a pressure of 5 ton by means of a hydraulic jack which is operated via a rotary lever. The press has the capability of dewatering the cassava mash.

1.6 LIMITATION

This project is limited only to manual operation. Materials required for the project are of high purchasing cost such as the galvanized mild steel pot recommended for food processing equipment.

CHAPTER TWO

2.0 LITERATURE REVIEW

All living organism need food for the metabolic activities of their body cells in essence, they all need food to survive. Man as a living organism also needs food to survive. Thus the production of food in quantity and quality to meet the demand of the consumers is of great importance. The ease of producing this food and obtaining maximum efficiency is the concern of present day engineers in the society. This project, the design and fabrication of a manually hydraulic jack for timed dewatering of cassava mash, which is presented in this report is aimed at increasing food production at a relatively cheap price.

The press was designed for use on dewatering of cassava mash in 5 minutes. Design considerations were taken with respect to rigidity, simplicity and ease of operation, portability, installation and maintenance in the design and selection of materials for the hydraulic jack. The machine part were subjected to strict design analysis, machine dimensions and component sizes were determined using mathematical equation and standard material selection charts – to prevent failure and ensure that each component parts perform the required function satisfactorily.

2.1.0 BRIEF DESCRIPTION OF CASSAVA

Cassava as a crop, (Manihot Esculenta). Cassava is the major stable food crop in the tropics. It is a perennial, vegetatively propagated shrub grown throughout the low land tropics. Fresh cassava contains about 62 to 65% moisture. It is highly perishable and has a storage life of less than 48 hours. Because of quick spoilage, farmers usually leave cassava roots in the ground after they have matured and harvest them for processing when required. An advantage with this crop is that harvesting can be spread over many months by leaving the roots in the soil. There are sweet and bitter varieties according to the cyanogenic glucose content which causes toxicity owing to the conversion into HCN. It is also influenced by the location where it is planted. (Elsevier, 1989).

2.1.1 CLIMATE

Cassava does well in warm area with an average daily temperature of 25 – 29^{0}C and it needs a minimum of 500mm of well distributed rainfall.

Otherwise, the crop can adapt itself to wide variety climate and soil. It is also draught resistant but if draught continues for several months this will affect the yield. Variation in day and night temperature promotes carbohydrates storage in the tubers. (Elsevier 1989)

2.1.2 PLANTING AND PLANTING MATERIAL

The land should be hoed or ploughed well and mound or ridges prepared because this makes digging easier at harvest time. The plants are propagated vegetatively. Any mature part of the stem is suitable for cutting, the middle portion is the best while, and use of the top part should be avoided. Cuttings are 20 – 30cm long and contain 4 – 6 nodes. Planting material should be taken from virus free plants; cutting can be planted in a vertical, oblique or horizontal position. A spacing or 1 meter x 1 meter is generally used where cultivation is done by hand, but the spacing can be changed to suit mechanical cultivation method. One hectare of cassava can supply planting material for 3 – 4 ha.

2.1.3 GROWTH PERIOD

Growth period varies between 12 and 24 months. In case of direct consumption, cassava is usually lifted about 12 months after planting for industrial processing; this is done at a later stage when the crop is 16 – 20 months old. (Elsevier, 1989).

2.1.4 Plant population: plant population is between 10,000 and 30,000 plants per hectares. (Elsevier, 1989).

2.1.5 FERTILIZER REQUIREMENT

Cassava is not very exacting in its fertiliser requirement. In case of intensified agriculture a considerable amount of fertiliser is needed especially nitrogen and potassium.

2.1.6 WEED CONTROL

Mechanical weeding is not advisable since the root system of cassava is rather superficial. At least two precisely timed weeding are needed to achieve optimum yield. Early weeding is important in cassava production (Elsevier, 1989).

2.1.7 PEST AND DISEASES

Pests, Red mites are widespread. Rot attaching grubs are frequently reported. Monkeys, wild pigs and rodent feed on the roots. There are disease tolerant cassava varieties. Bacterial wilt is also well known to cause severe yield losses. (Elsevier, 1989).

2.1.8 YIELDS

The average world yield is about 10 tonnes/ha but varies greatly from 7 tonnes/ha (Zaire) to 19 tonnes/ha (India) under suitable climatic conditions and with proper cultivation practise yield and reach 25 tonnes or roots/hectare (Elsevier, 1989).

2.1.9 HARVESTING

In lighter soils, the roots can be lifted simply by pulling while in heavier soil, lifting is done with a hoe. Since the roots kept in the soil can be harvested over a long period which is normally practiced in subsistence agriculture.

2.2.0 WORLD POPULATION

The world greatest producers of cassava in order of importance

Table 1.0 World population

Brazil	24,935 (thousand tonnes per hectare)
Indonesia	13,100
Thailand	12,500
Zaire	12,000
Nigeria	11,500
India	6,033

Total world population is 117,201 tonnes per year (Prudencio, C.Y. & Al-Hassan, R. 1994) and low, 1984). In West Africa, the four leading producers; in order are Nigeria, Ghana, Cameroun and Togo. Most of the cassava produced in West Africa is consumed locally and very little of it enters into international trade. (Prudencio, C.Y. & Al-Hassan, R. 1994onald and low, 1984).

2.3.0 CASSAVA FOOD PROCESSING

Cassava also known as Tapioca or Manioc is one of the most important cheap sources of carbohydrates in developing tropical countries. The various unit operation involved include peeling, washing, grating, drying, soaking, fermentation steaming, frying pounding, dewatering and others sun drying, soaking, fermentation and other activities are old proven remedies used to reduce cyanide level. Cassava can be eaten raw or boiled depending on variety or it can be processed into different products such as garri, fufu, lafun, starch e.t.c. Almost every household in rural Nigeria is involved in one or another form of cassava processing to satisfy the household demand or sell outside

2.3.1 ADVANTAGES OF CASSAVA AS A CROP AND FOOD

(1) It is a cheaper source of energy

(2) It can be stored for up to 2 years in the soil

(3) Cassava processing provides employment and income

(4) It can be cultivated easily

(5) It serves as raw material in the production of ethanol.

2.4.0 OBJECTIVE OF CASSAVA PROCESSING

(I) Elimination or reduction of cyanide content. Processing is a key element in reducing the concentration of hydrogen cyanide in cassava tubers and leaves. Reduction in concentration of the toxic element to a safe level is necessary for both human and animal consumption. Consumption of inadequately processed cassava has chronic effect on health and nutritionally well-being and it can also lead to death.

(II) Reduction post harvest losses of fresh tubers as cassava is extremely perishable and must be either consumed or processed within 24 – 48 hours of harvest (S.A. Odunfa, 1997)

(III) Removal of the inedible parts.

(IV) Processing leads to the conversion of the perishable roots into staple products of prolonged shelf life.

(V) Processing also improves palatability and increase variety in the diet by providing a range of attractive flavours colours aroma and texture in food.

(VI) It improves the net economics value of the product by raising its quality

2.5.0 PRINCIPLE OF PROCESSING TECHNIQUE

Approximately two-third of the cassava used in Africa for food is eaten after specialized traditional processing usually at the farm or village level. The processing methods compose combinations of some of the following activities: peeling, boiling, steaming, slicing/chipping, grating, soaking or sleeping, fermenting, pounding, frying, roasting, dewatering, sieving, drying, and milling.

2.5.1 PEELING

This involves the removal of the inedible outer layers of the cassava and is traditionally done with a knife.

2.5.2 WASHING

This involves soaking the peeled or unpeeled tubers in a pool of water and washed with aid of scotch pad cleaning should take place at the earlier opportunity in a food process both to prevent damage to subsequent processing equipment and to prevent time and money from being spent on processing contaminants which are then discarded. Washing is thus an effective method of reducing wastage, improving the economics of processing and protecting the consumer.

2.5.3 GRATING

The action of grating into fine shreds or pulps is a step common in the processing of many cassava food products and facilitates subsequent steps in process e.g. dewatering, drying or pulping. The process alters the texture of the raw material.

2.5.4 FERMENTATION

Fermentation is an important step in the processing of cassava. Fermentation result in a reduction in the level of toxic components. In fermenting cassava, two methods are commonly practiced which may be conveniently considered as the dry and wet methods.

The dry method is used in the production of garri and is essentially fermentation in the presence of air. The grated cassava passes through two stages of fermentation. During the first stage starch is broken down and acid is produced. Subsequently, breakdown in the cyanide containing toxic component occurs through the action of naturally occurring enzymes in the root releasing hydrogen cyanide. The condition at the end of this first stage allow the growth of a range of microorganism that produce compounds which give garri its characteristic flavour. Much of the cyanide is lost during fermentation, the remainder being largely driven off during the final roasting step.

The simple wet method of fermentation sometimes referred to as retting takes place in the absence of air. Cassava roots either peeled or unpeeled are soaked in water for several days until they soften. The material is then broken up, sieved and finally squeezed to remove water.

2.5.5 DEWATERING

Dewatering as the name implies, involves the removal of internal liquid from the cassava by pressing. It is an important method of reducing toxicity. Traditionally, heavy weights are placed on the prepared pulp and expelled liquid is allowed to drain away. Improved method uses presses such as screw press or hydraulic press.

2.5.6 STARCH EXTRACTION

Industrially, starch is extracted by a combination of wet milling, sieving and either centrifuging or setting. Starch can also be extracted by simpler methods. The juice draining from cassava during dewatering may be collected and left to stand allowing the starch to settle. After decanting the liquid layer, the remaining starch may be rimed and further processed into flour by pounding or grinding.

2.5.7 SIEVING

Sieving is done with the purpose of removing the excess fibrous material and to separate undesirable particles from mixed materials as used. In starch extraction and garri. Separation is achieved using sieves made out of metal or local plant material or finely woven cloth material in case of starch extraction.

2.5.8 FRYING OR ROASTING

Frying or roasting is the most difficult part in garri processing and is normally done on earthen ware oven, the fuel efficiency of which is very low. Apart from its low fuel efficiency, it compounds its negative effective by heating the immediate surrounding which include the women fryers.

In Garri processing, proper roasting is important to ensure a good quality product. Both frying and roasting enhances the flavour of cassava and most importantly reduces its moisture content. When packed properly, fried products can have a shelf-life of several months.

2.5.9 DRYING

Drying is the elimination of excess water from the material in order to bring the total moisture content to a level considered to be safe for long-term storage. The excess water in cassava or other agricultural produce is responsible for intensive microbial activity leading to the formation of molds and general deterioration of the product.

Drying is mostly done in the open air under sunlight on the roofs of buildings, roadsides, concrete patches, spread on mats or directly on tamped soil.

2.6.0 USES OF CASSAVA

2.6.1 The Roots

In Nigeria both "Sweet and bitter" varieties are cultivated. Despite their higher cyanide content, the bitter varieties are more predominantly utilized. This is possibly due to its better organoleptic qualities and amylase: amylopectin ratio than the sweet variety, as well as higher resistance to endemic diseases.

Techniques have been developed for processing them to safe products. The roots are primarily produced for food especially in the form of garri, fufu and lafun (Elubo).

2.6.2 GARRI

The chemical composition of cassava roots shows that it is the principal source of carbohydrate for the consumers. Garri, one of the traditional products of cassava processing, is commonly consumed by the rich and the poor, the elite and the uneducated, and is now being exported to other parts of the world.

2.6.3 FUFU

Cassava fufu, another product of cassava fermentation, is now enjoying patronage even among the elite. This was due to the efforts of scientists at NRCRI, Umudike, who in 1984 successfully produced cassava fufu (wet and dried) devoid of the inherent and repulsive foul odour. Many industries and small-scale production plants have been set up in cassava producing villages and hamlets to produce packaged odourless fufu, and "instant" cassava flour (its unfermented counterpart) with low cyanide levels (< 50 ppm).

2.6.4 TAPIOCA AND FLOUR

Tapioca or thinly sliced cassava chips (or strips) is a commonly delicacy among the Igbos, Efiks, Ibibios and Deltans. In the dried form, the slices can be exported or stored for upwards of 6 months without loss of essential organoleptic properties. When needed, the slices can be machine – milled into powder for the production of flour.

2.6.5 CHIPS FOR LIVESTOCK FEEDS

Cassava tubers constitute an important component of livestock feed production in various parts of the world. They can be processed into chips and pellets, which are mainly used in the formulation of feeds for cattle, pigs, poultry and other livestock.

2.6.6 CASSAVA FLOUR FOR BAKERY AND CONFECTIONERIES

Studies carried out in various R and D institutions have identified a number of other uses for cassava roots. Cassava flour and starch can be used in diverse ways to produce delicacies. These include cakes, biscuits, chin-chin, pastries, akara balls, strips and flour cookies. Trials on the use of cassava as a replacement/supplement for wheat in bread making have finally yielded positive results. The efforts of the Federal Institution of Industrial Research Oshodi (FIIRO's) have resulted in the recent draft national policy on 10% cassava bread supplement for wheat in the bread industry. This policy when fully adopted by bakers will further reduce the level of wheat importation in the bread industry. It will also increase the level of production of cassava.

2.6.7 OTHER USES OF CASSAVA ROOTS

The high carbohydrate (particularly starch) content and other qualities such as the amylase-amylopectin ratio, predispose cassava roots for use in various industries. They can be processed into several secondary products of industrial and international market value.

Apart from the chips and pellets for animal feed production and the native starch and flour, other products include modified starch, ethanol, monosodium glutamate (MSG), glucose, fructose, sorbitol, sago, citric acid, adhesives, syrups, microbial enzymes, sweetners e.t.c.

2.7.0 THE NEED TO DEWATER CASSAVA MASH

De-watering or pressing is a process that can remove up to 50% of the water present from the root crop. The process is most common in cassava processing where it is an important method of reducing toxicity. Traditionally heavy weights are placed on the prepared crop to press out the liquid, which drains away. There are several press designs available, ranging from the simple easily constructed parallel press to the more sophisticated screw press or hydraulic press.

Table 2.0 Chemical Composition Of Fresh Cassava Tuber

Chemical Composition (%) Of Fresh Cassava Tuber

Matter		%
(1).	Moisture	65 – 70 %
(2).	Starch	0.7 – 1.1%
(3).	Protein	21.5%
(4).	Fats	0.42%
(5).	Fibre	1.10%
(6).	Ash	0.54%
(7).	Dry Matter	35 – 58%

CHAPTER THREE

3.0 MATERIAL AND METOHDS

3.1 DESIGN CONSIDERATION AND MATERIAL SELECTION

The cassava dewatering machine is manually driven by hand through a turning lever, lever, the lever arm reciprocates the hydraulic jack pump to lift the jack, and the jack shaft as it protrudes lifts the perforated cylindrical tank against the stationary plate placed above the tank. This compression action squeezes the water content of the cassava in the tank and the water drains out through the perforations on the tank.

Economy is the basis of any good design hence materials used were carefully selected so as to serve the specific purpose for which they were meant, while at the same time considering cost.

The properties of the materials must include resistance to corrosion because corrosion may contaminate the cassava thereby limiting its consumption values.

Materials like stainless steel, brass, grey cast iron have better advantages over others but for availability and economic reasons, galvanized mild steel was chosen for this project.

The design features of each of the parts are discussed below:

3.1.1 MANUAL FORCE

The machine is powered manually by hand; this makes human force the driving power of the machine.

3.1.2 POWER LEVER

These components will serve the purpose of transmitting power from the human effort to the hydraulic pump. The power lever has a diameter of 25mm and a length of 250mm.

3.1.3 TANK

The tank is made of galvanized mild steel sheet; it serves the purpose of holding the cassava while it is being dewatered through the perforations on it. It has diameter of 300mm and a height of 400mm.

3.1.4 WATER DRAIN

The water drain is made of galvanized mild steel sheet it drains off the water being squeezed out of the cassava outlet. The water drain is located at the base of the tank.

3.1.5 TOP DISC

The top disc is a circular metal plate with diameter of 320mm and thickness of 3mm it serves as a pressure plate for squeezing the cassava in the tank against.

3.1.6 FRAME

The frame is made of C-section galvanized mild steel of 70mm by 40mm. The frame supports the top plate and other components of the machine.

3.1.7 HYDRAULIC JACK

The hydraulic jack is the lift unit which raises the tank pressurizing it against the top plate. The hydraulic jack has a force capacity of 5 tons

3.2 DESIGN ANALYSIS

3.2.1 POWER REQUIREMENT

The power requirement for the groundnut paste machine can be modeled into three sections as listed below

a. Power required to compress the cassava.
b. Power required to drive the hydraulic pump.
c. Power required to drive the lever.

The summation of these separate power components gives the total power (P_T) required by the machine.

Given that

P_T = total power

Pc = Power required to compress the cassava

P_h = Power required to drive the hydraulic pump

Pw = power required to drive lever.

:- Total power (P_T) = Pc +P_h + Pw

Power to compress the cassava Pc:

$$Pc = \frac{W}{T}$$

$$W = mg \times d$$

Where

W = work done by hydraulic jack in compression

m = maximum load capacity of hydraulic jack 5 Ton (5000kg)

d = maximum distance traveled by jack = 140mm (0.14m)

T = dewatering time = 5 minutes=300seconds

$$W = 5000 \times 9.8 \times 0.14 = 6860Nm$$

$$Pc = \frac{6860}{300} = 22.87Nm/s \text{ (watts)}$$

P_h = Power required to drive hydraulic pump

$$P_h = \frac{W}{T}$$

$$W = F \times d$$

where

F=minimum force applied on hydraulic pump lever =40N

d = length of hydraulic pump lever = 0.25m

T= time = 5 minutes = 300 seconds

$W = 40 \times 0.25 = 10Nm$

$$P_h = \frac{10}{300} = 0.033 \text{ watt}$$

Pw = power required to drive lever.

$Pw = Mr\omega$

where

M=mass of lever by weighing = 2.0Kg

r= radius = 0.15m

ω= angular speed rad/s

$$\omega = \frac{2\pi N}{60} = \frac{2 \times \pi \times 30}{60} = 3.146 \text{ rad/s}$$

$Pw = 2.0 \times 0.15 \times 3.146 = 0.9438$ watts

:- Total power (P_T) = 22.87 +0.033 + 0.9438 = 23.85watts

Power required to power the cassava dewatering machine is 23.85 watts

This indicates that the machine can be driven by a minimum power of 23.85watts

3.2.2 VOLUME OF TANK

$$V = \frac{\pi d^2}{4} \times h$$

Where,

d = tank diameter = 0.35m

h = tank height = 0.35m

$$V = \frac{\pi \times 0.35^2}{4} \times 0.35 = 0.03367m^3$$

3.2.3 DETERMINATION OF TANK THICKNESS

The casing has to be constructed considering its thickness to withstand the increase in pressure.

From the relationship,

$$Ph = 2t \times S_h$$

(Gitini, M.M Prasad 1986)

Where,

Ph = Maximum pressure on the casing = 28 x 10^6N/m^2

$$pressure = \frac{F}{A} = \frac{5000 \times 9.8}{\pi 0.35^2 / 4} = 509295.8N/m^2$$

D_i = Internal diameter of the tank = 0.35m

S_h = Tensile strength of the material to be used = 450 X 10^6N/m^2

t = thickness of tank

$$t = \frac{Ph}{2 \times S_h} = \frac{509295.8}{2 \times 450000000} = 0.000566m$$

t =0.5mm

3.3 FRAME ANALYSIS

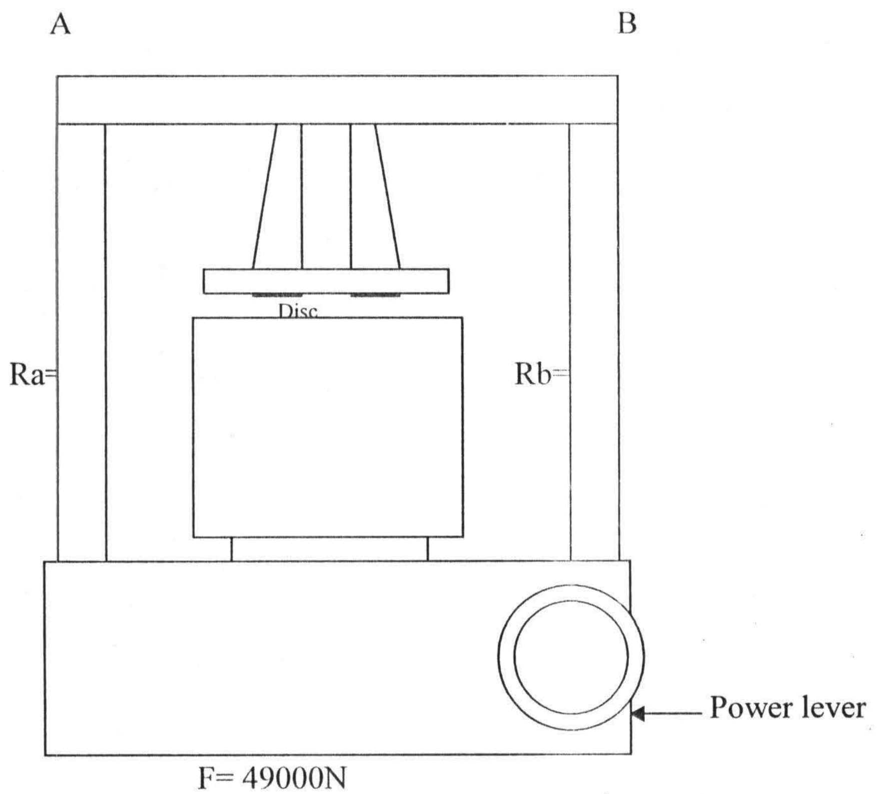

Fig. 3.0 Frame of Hydraulic press

From the above figure we have the force diagram below

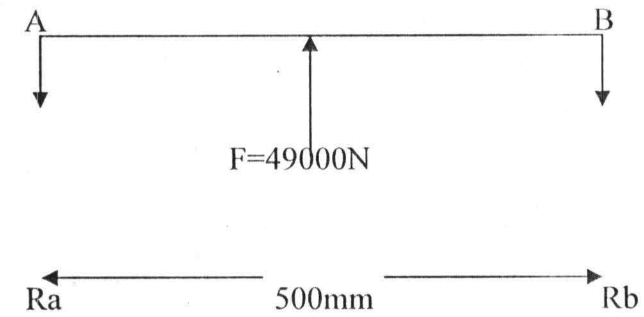

Fig 3.1 Shear force diagram

Summation of moments about point A = 0

$0.25F - 0.50Rb = 0$

$0.50Rb = 0.25F$

$$Rb = \frac{0.25 \times F}{0.50} = \frac{0.25 \times 49000}{0.50} = 24500N$$

Summation of upward and down ward force = 0

$$Ra - F + Rb = 0$$

Therefore

$$Ra = F - Rb$$

$$Ra = 49000 - 24500 = 24500N$$

Bending Moment

$BM_B = 0$

$BM_C = - 0.25F$

$= 0.25 \times 49000$

$= -12250$ Nm

$BM_A = - 0.25F_C + 0.50R_B$

$= - (0.25 \times 49000) + (0.50 \times 24500)$

$= 0$

Therefore maximum bending moment is -12250Nm and it occurs at point 'C'

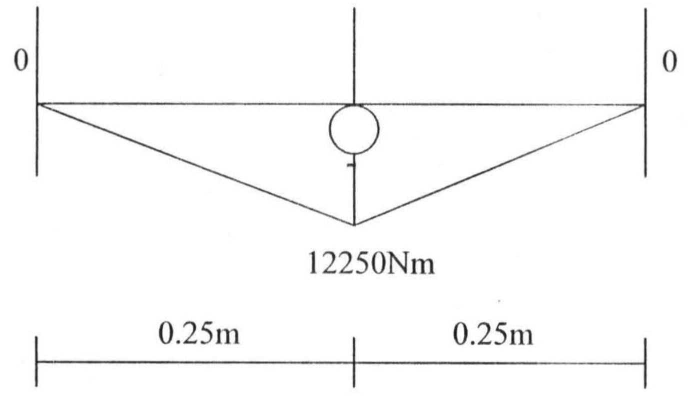

Fig. 3.2 Bending moment diagram

3.4 THROUGH PUT CAPACITY

The throughput time of the machine is given by

$$\text{throughput capacity} = \frac{\text{processed mass}}{\text{time taken}}$$

$$\text{processed mass} = density \times volume$$

Where

average density of cassava =641kg/m^3

volume = 90% tank volume=0.0303m^3

processing time = 5minutes =5/60Hr = 0.08333Hr

$$\text{processed mass} = 641 \times 0.0303 = 19.4kg$$

Hence

$$\text{throughput capacity(kg/hr)} = \frac{19.4}{0.08333} = 232.8kg / Hr$$

CHAPTER FOUR

MATERIAL SELECTION, CONSTRUCTION, ASSEMBLY OF MACHINE AND COST OF MATERIALS

4.0 MATERIAL SELECTION:

Material selection is very important in machine design; they are very decisive factors for good design.

The choice of a particular material for a machine depends on the purpose and mode of operation of the machine components. It also depends on the experimental mode of failure of the components.

4.1 MEDIUM CARBON STEEL

Medium carbon steel contains 0.30 to 0.55 percent carbon and required increased hardness, strength, good resistance to fatigue as well as low cost. Medium carbon steel can be heat treated to develop high strength. It is suitable for the manufacture of gears, rollers (crusher) pulley sleeve. They are ductile and tough.

4.1.1 MILD STEEL

Mild steel contains 0.05 to 0.25 percent carbon. It has almost for all purpose replaced wrought iron, its greater strength gives it advantages. Mild steel can be rolled, welded and drawn. Among it applications are plate for ship building, bicycle frame, bolt, nuts, studs, high – quality sheets for automobiles. it is used in this project for the body frame and shaft.

The choice of mild steel therefore for the purpose of this project was greatly influenced by the following:

1. The relatively low cost of purchasing mild steel from the market.
2. Easy availability of mild steel for the working conditions based on a careful consideration of necessary mechanical properties.

4.1.2 GALVANIZED SHEET METAL

Galvanized sheet is the material choice for the covering of the working parts and fabrication of the perforated tank. It has excellent corrosion resistance. They are tough and ductile.

4.2 TESTING AND RESULT

Cassava dewatering was tested at full capacity load of 90% of the tank volume. Compression was achieved to 60% of the volume for five (5) minutes and the cassava was weighed to determine the water loss. The output of the test was collecteed after dewatering and weighed. The mass of the liquid content extracted was density of water 1000Kg/m^3X 30% of 0.0303 = 9.09Kg.

4.3 COST ESTIMATE

The cost of project is represented by three basic unit cost, which are:

(a)Material cost

(b) Labour cost

(c) Overhead cost

4.3.1 MATERIAL COST

Direct material cost is the cost of materials that can be identified in the finishing product. The cost estimates of materials used for the fabrication of the sugarcane juice extracting machine are tabulated in table 3.0

4.3.2 LABOUR COST

Direct labour cost is the cost of working with some of the machines in the workshop for the fabrication of product. The direct labour cost consist the cost of machining the Shafts, drilling, riveting of frames and welding of structural members. For the fabrication of this project, the direct labour cost was 40% of material cost

TABLE 3.0 MATERIAL COST

S/N	DESCRIPTION	QTY	UNIT COST	TOTAL COST
1	Angle bar (stand) 3000 x 40 x 40	2	1,500	3,000
2	Spring(extension) Φ 50 x120 mm	2	1,000	2,000
3	Shaft	1	1,000	1,000
4	Galvanized steel plate 1mm thick	½ sheet	3,000	3,000
5	Power lever	1	1,000	1,000
6	Hydraulic jack 5 ton	1	4,000	4,000
7	Mild steel plate 4mm	1	300	300
	TOTAL			14,300

Material cost =14,300

Labour cost = 40% of material cost = 5,720

4.3.3 OVERHEAD COST

This is the sum of indirect material cost of indirect labour cost. This is the total cost of fabricating the product which cannot be identified in the project. The overhead cost was ₦2,000.

4.3.4 TOTAL COST

Total cost is the sum of the direct labour cost, direct material cost and overhead cost. For the fabrication of the machine, the total cost is as follows:

TABLE 4.0 TOTAL COST ESTIMATE

Description	cost (₦)
Direct material cost	₦14,300
Direct labour cost	₦ 5,720
Overhead cost	₦ 2,000
TOTAL COST	**₦ 22,020**

CHAPTER FIVE

5.1 CONCLUSION

In the performance test of the cassava dewatering machine the following observations were made.

The force exerted by the 5 ton hydraulic jack was sufficient to dewater the cassava satisfactorily within 5 minutes.

The manual force required in spinning the power lever was small which makes the machine easy to run.

5.2 RECOMMENDATION

In view of the need for higher machine efficiency I will recommend that the mass capacity of the machine be increased by increasing the tank volume and hydraulic jack capacity.

The machine should be designed to operate using electrical power rather than manual power.

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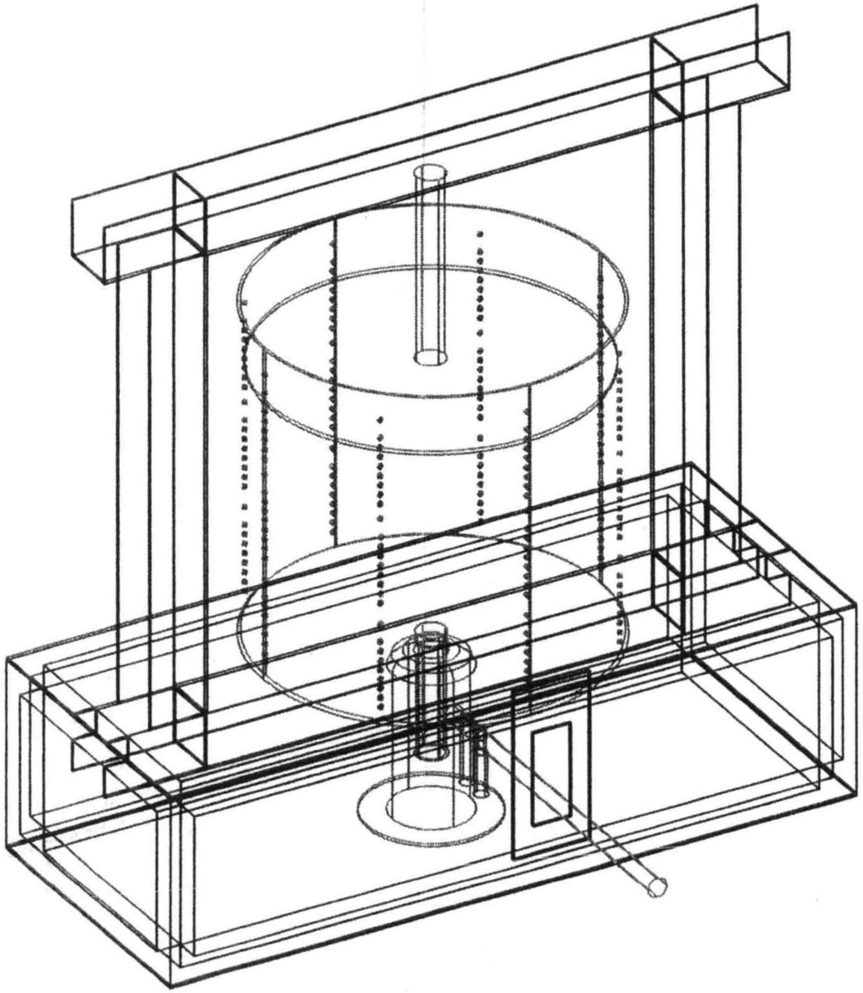

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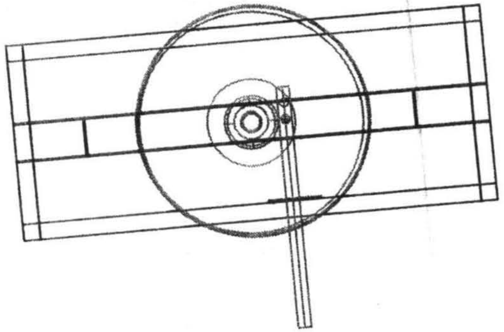

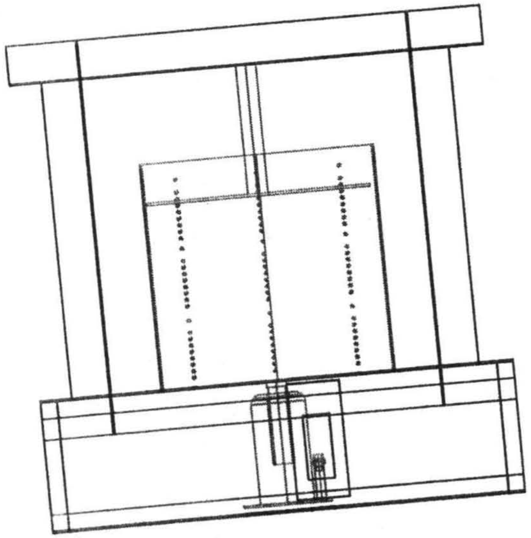

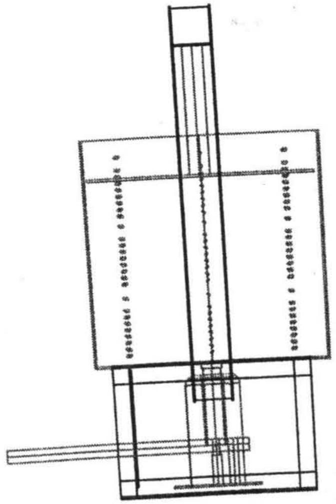

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