DESIGN, FABRICATION AND PERFORMANCE EVALUATION OF A GROUNDNUT OIL EXPELLING MACHINE

BY

LEMAH OLAKUNLE
2006/24064EA

DEPARTMENT OF ARICULTURAL AND BIORESOURCES ENGINEERNG FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

FEBRUARY, 2012.

DESIGN, FABRICATION AND PERFORMANCE EVALUATION OF A GROUNDNUT OIL EXPELLING MACHINE

BY

LEMAH OLAKUNLE
2006/24064EA

BEING A FINAL YEAR PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG.) DEGREE IN AGRICULTURAL & BIORESOURCES ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

FEBRUARY, 2012.

DECLARATION

I hereby declare that this project work is a 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 or institution. Information derived from personal communications, published and unpublished work were duly referenced in the text.

Lemah Olakunle

2nd March, 2012.

Date

CERTIFICATION

This is to certify that the project entitled "Design, Fabrication and Performance Evaluation of a Groundnut Oil Expelling Machine" by Lemah, Olakunle meets the regulations 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.

______________________ 29/02/2012

Engr. Dr. P. A. Idah — Date

Supervisor

______________________ 29/02/2012

Engr. Dr. P. A. Idah — Date

Head of Department

______________________ 22-02-2012

External Examiner — Date

DEDICATION

This project is dedicated to almighty God. My dearest and beloved father Lemah, Oluwole Samuel and my sweet mother Mrs. Eunice, Abiola Lemah, who supported me spiritually, financially and morally from cradle to the end of my undergraduate study.

ACKNOWLEDGEMENTS

It remains a fact that it was the help of almighty God through his son, my lord and saviour, Jesus Christ that this educational pursuit was accomplished. Therefore, with deep sense of appreciation and gratefulness from the depth of my heart, I thank him for his mercy, grace, and love lavished on me to have attained this level of academic goals, am most grateful.

My sincere and deep appreciation goes to my supervisor Engr. Dr P. A. Idah, for his exceptional and productive assistance especially his balanced constructive criticism towards the success of this project.

My profound gratitude goes to the Head of Department Engr. Dr P. A. Idah and my lecturers Engr. Prof. B. A. Alabadan, Engr. Prof. I. N. Itodo, Engr. Dr D. Adgidzi, Engr. Dr I. E. Ahaneku, Engr. Dr N. A. Egharevba, Engr. Dr M. Y. Otache, Engr. Dr Z. A. Osunde (Mrs.), Engr. S. E. Adebayo, Engr. P. A. Adeoye, J. J. Musa, Engr. H. I. Mustapha, Engr. B. A. Orhevba, Engr. Sadiq, Mallam H. Adamu. Special thank goes to the project coordinator, Engr.Dr.O.Chukwu who took his time to lecture us on project writing.

I also thank the technical staffs such as: Engr. I. A. Mohammed, Engr. Kehinde, Alhaji A. B. Adamu, Mallam Saidu Zegi, Muhammed Sani, Mudi Usman Abubakar, Abubakar Ndagi, Aliyu G. Garba Aliyu Umar Kabir Mrs Helen E. Omale and the rest.

My profound gratitude goes to my parents, Mr. &Mrs. S. O. Lemah who toiled day and night to see to the successful completion of my study and for their effective parental responsibilities to have supported me to this extent, I am indebted to you. Also to my siblings, Mr. Olusegun A.

Lemah, Mr. Femi B. Lemah, Mr. Ayorinde Lemah, Jumoke Lemah (Mrs.), Miss Abiose Lemah and Miss Oriola Lemah for your support during my course of study.

My appreciation goes to my friends: Musa Livinus, James Godwin, Calistus Aku, Mark Azubuike, Opeyemi Micheal Kolade, Cosmas Ikenna, Ismaila Gbatigbi, Francis Ayemere, Olajumoke Owolabi Olapeju, Suleiman Emmanuel, Simon Ebenogwu, Chimex,Willams and all my course mates too numerous to mention.

Finally, my unreserved gratitude and sincere appreciation go to my group members in the persons of Miss Lilian Ikhide Omotese, Mr. Samuel Elijah Babatunde, and Mr. Dare Suleiman for your unalloyed support and cooperation, and the rest of my friends and relatives that their names are not included.

ABSTRACT

The design and fabrication of an oil expelling machine was undertaken with the aim of achieving efficient roasting of groundnut and extraction of the oil within a given floor space as well as eliminating the drudgery associated with it. The machine was designed and fabricated using locally available materials. The machine consists of a roasting unit and an expelling unit. The roasting unit consists of a hopper, conveyor trays, a vibrator mounted on the frame of the trays, which agitates the groundnut seeds constantly in the roasting chamber. There is a heating filament directly under the roasting chamber which supplies the heat. The roasting chamber is insulated to reduce heat loss. The expelling unit consists of an electric motor, which powers the expeller, a gear box, which reduces the speed of the electric motor, an expeller to extract the oil and a control lever to adjust the clearance of the expeller. The frame is made of angle iron on which the entire assemble is mounted. The machine performance evaluation was carried out; the roasting unit efficiency was 66.7% while the expelling efficiency was 66.7%. Therefore, the design and fabrication of the machine satisfies the following conditions; portability, space reduction, time reduction and cost.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABREVIATIONS OR SYMBOLS OR NOTATIONS

FFA	(Free Fatty Acid)
F. A. O.	(Food and Agricultural Organization)
USDA	(United State Development Agency)
ω	(Omega)
ϕ	(Phi)
θ	(Theta)
δ	(Delta)
τ	(Thaw)

APPENDICES

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Groundnut, *Arachis Hypogaea* originated from Eastern Bolivia at the foothills of Andes (Asiedu, 1989). The Portuguese navigators introduced groundnut from South America to Africa (Anyanwu *et al*, 1986). The crop is grown throughout the tropical and warm temperate regions of the world with it largely grown in USA, Brazil, China, Senegal and Nigeria (Asiedu, 1989). It is the third major oil seed of the world next to soya bean and cotton (FAO,1990). China, India, and USA have been the leading producers of groundnut. In USA during 1989-1990 groundnut production was estimated at 1.8 million tonnes (FAO, 1990). Most of the oil consumption is obtained from groundnut.

Currently, groundnut is being under-utilised in Nigeria which is one of the largest producers of the crop in the world. Before the oil is extracted for uses, it goes through different unit operations which involves many labour and is time consuming.

Oil extracted from groundnut is subjected to operations like shelling of the nuts, separation of the nuts from the shells, roasting of the nuts, decorticating and milling.

Recently, great economic importance is attached to the production of groundnut in Nigeria. With the adoption of improved technology and increase in market demand, its production is likely to increase. Hence, the need to produce a machine that will reduce drudgery, time and cost to the bearest minimum in oil production. However, the stress in carrying out each unit operation during oil extraction has been a challenge that is left for peasant farmers to contend with.

In some rural communities, roasting of the seed is done traditionally. This process is very slow, time consuming and tedious hence it is incompatible with the present level of production. In order to increase and sustain production level of groundnut, small scale farmers must be provided with means by which their products can be processed with reduction in drudgery, time and cost effective, yet achieve good quality product.

Over the years, different mechanical means of achieving each unit operation in groundnut oil production have been developed, but the major problem has been the movement of the seeds from one location to another during production thereby taking much time to process with improper material handling. Therefore the main objectives of this project work is to develop a simple oil expeller with unit operation starting from roasting operation to oil extraction as one entity, since shelled groundnut are readily available in the market.

1.2 Statement of Problem

The labour and time involved in carrying out groundnut oil processing when the unit operations are many and far apart is of great concern. Reducing the time and labour required by combining some of these unit operations can greatly save cost of production. Hence, the need for this current study.

1.3 Objectives of the Study

i. To design and fabricate continuous groundnut roaster using locally available materials in order to improve on the extraction processes.

ii. To carryout performance tests on the developed roaster.

iii. To design and fabricate groundnut oil expeller with an integrated roaster so as to reduce cost of production, sales time, labour and also merge two processing operation units together.

1.4 Justification of the Study

There is a problem when several units of the oil processing operations are separated. The time taken to move the raw materials from one unit to another is sometimes enormous. Apart from that the labour require to man these separate units also add to the cost of production. However if some of these units can be integrated it can greatly enhance the efficiency of the entire process. It is in view of this that this present study is been carried out to combine the roasting and expelling units of a groundnut oil processing into a single unit.

1.5 Scope of the Study

The scope of the study is to design, fabricate and test groundnut oil expeller with roasting unit in order to reduce drudgery, save labour, time and cost.

Also, the research work is split into two with two students working on the roasting unit while the other two students are working on the expelling unit therefore this particular research work focus on the groundnut roasting unit.

CHAPTER TWO

2.0 Literature Review

2.1 Groundnut Production

Groundnut belongs to the family Leguminosea and the sub-family Papilionaceae. It is grown as an annual crop on 19 million hectares in the tropical and sub tropical areas of the temperate regions of the world (FAO, 1990). Principally they are produced for their protein rich kernels or seeds.

The world production is estimated at 17.8 million tonnes of which China is leading with 41.5% of the world production followed by India with 18.2% and the United States of America having world production of 6.8% (USDA, 2009).

Nigeria accounts for 41% of total groundnut production in West Africa (Abalu and Etuk, 1986). The groundnut produced in Nigeria is considered to be of South American origin. It was introduced to West Africa by the Portuguese in the sixteenth century (Asiedu, 1989).

They are produced predominantly in the northern Nigeria (Maiduguri, Kano, Katsina, Niger etc.) (Agboola, 1979). This is due to the modest moisture requirement of the crop and the presence of extensive light sandy soil. Table 2.1 shows the various growing production countries of the world and their production figures.

Table 2.1, The countries involved in the Production of Groundnut

Countries	Production (Thousand Tonnes)
1. India	8,200
2. China	5,580
3. USA	1,943
4. Nigeria	1,037
5. Indonesia	578
6. Senegal	578
7. Myanmar	466
8. Sudan	454
9. Argentina	320
World	23,506

Source: (FAO, 1990)

2.2 Physical Properties of Groundnut

The effective performance of most agricultural machines is influenced decisively by the physical properties of the materials and so in order to study and process (for example, groundnut shelling), they must be described accurately (Sitkei, 1986).

According to Tindall (1983), the pod of a groundnut is about 12.5 – 75mm in length and roughly cylindrical in shape. The shell of the pod comprises 20 – 300 percent of the whole nut and may be separated from the kernels. The kernel consists of two cotyledons (halves) and the gern (heart) envelop in thin red-brown, purple or white slain called the Testa. The kernels are made up of about 72.4 percent cotyledon, 4.1 percent skin and 3.3 percent germs.

The aerodynamics properties of agricultural products are important and are required for designing of air and water converging systems and the separation equipment (Sahay and Singh, 1994). The two most important aerodynamic characteristics of a body are its drag coefficient and the terminal velocity. The aerodynamic properties of groundnut seeds depend upon such factors as the dimensions, velocity, form, weight and surface texture of the seeds. The average weight of the groundnut seed is 2.98×10^{-4} kg. These properties are taken into consideration in constructing machine for cleaning and sorting of seeds. (Tindall, 1983).

2.3 Uses and Importance of Groundnut

Groundnut is used mainly:

- For direct consumption;
- As feed for livestock;
- As 'green manure" for farmers;
- As raw materials for many industrial products.

Also serves as a source of income or revenue for the government.

Groundnut crops are grown for their kernels, the oil and meal derived from it and the vegetable residue (haulms). As human foods, the kernels are eaten raw, lightly roasted or boiled; sometimes, salted or made into paste, which is known as peanut butter. In Senegal, the leaves of the plant are used as a vegetable in soups. (www.appropedia.org)

Groundnut oil forms an important part of the diet and on the average the oil content of the kernel is between 40 – 50 percent mainly for cooking. The best oil is obtained by simple press and is called "cold pressed oil" whereas oil of inferior quality is obtained by further pressure and heat, and is mainly used for soap making. (www.appropedia.org)

It was however reported that almost every part of groundnut is used in some way. According to Idama (2000), over 330 products can be commercially produced from groundnut and jobs can be directly created from massive groundnut production with small improvement in the technology. One major product which is groundnut oil, has suffered a major setback due to lack of improved ways of extracting the oil from the kernel. However, the mechanized machines imported into the country were found to be expensive.

2.3.1 Non-Food Uses of Groundnut

The shells, skins and kernels of peanut maybe used to make vast variety of non-food products. For example, the shell may be used in wall board, fireplace logs, fibre roughage for livestock feed and kitty litter. The skin may be used for paper making. (www.appropedia.org)

Groundnut is often used as an ingredient in other product like detergent, salves, metal polish, bleach, ink, axle grease, shaving cream, face creams, soap linoleum, rubber cosmetics, paints, explosives shampoo and medicine (USDA 2011).

2.4 Oil Content in Groundnut

In Nigeria, important research has been carried out to improve the first generation groundnut, varieties, this first generation refers to the Spanish, Virgina and Runner types. Continued research (IAR, 1989) has resulted in the release of several improved varieties. These varieties have high oil content than the formal types. The three initial types have oil content which ranges from 41 to 58.6% while the modified varieties have oil content ranges from 50.52 to 55.65% as indicated in table 2.1.

Table 2.2: Groundnut Varieties with Oil Content

Variety	Oil Content (% dry basis)	Year of release
SAMNUT 1	53.55	1960
SAMNUT	253.55	1960
SAMNUT 3	53.65	1970
SAMNUT 4	55.65	1970
SAMNUT 5	51.50	1970
SAMNUT 6	52.50	1970
SAMNUT 7	51.53	1980
SAMNUT 8	55.60	1980
SAMNUT 9	50.53	1980
SAMNUT 10	55.60	1988
SAMNUT 11	55.60	1988
SAMNUT 12	51.63	1980
SAMNUT 13	50.53	1980
SAMNUT 14	50.52	1988
SAMNUT 15	50.53	1970
SAMNUT 16	55.60	1980
SAMNUT 17	53.55	1988
SAMNUT 18	53.55	1988

NOTE: SAMNUT = Samaru groundnut

Source: Ola (2000)

2.4.1 Traditional Processes of Oil Extraction in Developing Countries

Traditional systems of groundnut oil extraction in developing countries involve the use of both manual and small engine operated machines. Though literature on the traditional processing methods and the equipment used, there-off, is very scanty (Nalumansi and Kaul, 1992). The various techniques applied for each processing operation are summarised in table 2.3

Table 2.3 Traditional Techniques for Processing Groundnut Oil Extraction

Operation	Typical Traditional Technique
Removing nuts from shells.	Done manually or by hitting with stick
i. Winnowing assistance	Using flat baskets or pans with current.
ii. Sorting	Done manually
iii. Roasting	a. Done in open pans over direct fire b. By exposing the groundnut under direct solar heat.
iv. Skinning	a. By rubbing the nuts between a wood and concrete or mat. b. By rubbing the nuts between two stones. c. By rubbing the nuts between a stone and a mat or jute bag.
v. Grinding into paste	a. Done with assistance of a mortar and Pestle manually or with animal power (called Ghani in India). b. Rubbing between flat stones
vi. Primary oil extraction	a. `By exposing the crushed meal to the heat of the sun. b. By compressing the meal in baskets using wooden levers. c. By kneading using a mortar and pastle either manually (as in Nigeria or animal power (as in India)

Operation	Typical Traditional Technique
	d. By adding boiling water to the meal stirring and scooping the oil off the surface (common in Ghana)
vi. Secondary oil extraction	By hand pressing or kneading on a wooden board (ruling) or wide flat stone.
vii. Frying the rolled meal (or minor purification). (Vii) and (viii)	Frying with oil extracted from extraction and oil pan over fire.

Source: Asiedu, (1989)

Asideu, (1989) showed a diagrammatic sequence of traditional oil extraction method in West Africa as showed in Figure 2.1

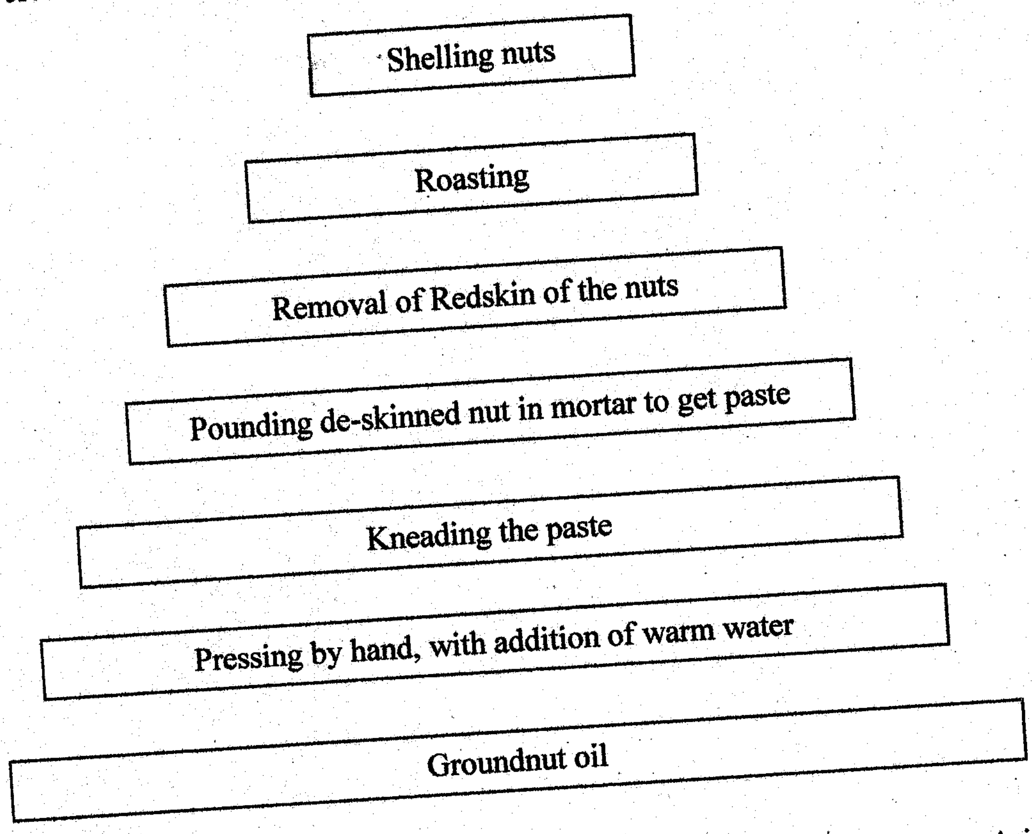


Fig 2.1 Diagrammatic sequence of the traditional oil extraction in West Africa. **Source:** Asiedu (1969)

Kordylas (1990) explained that groundnut oil is produced by roasting the kernels and grinding them into paste. The paste is mixed with water and boiled. The oil rises to the top and skimmed off. The extracted oil is further heated to drive off moisture. It is then cooled and bottled. Alternatively, the kernels are steamed and crushed in an expeller, a screw press or hydraulic press is used to extract the oil.

Sanda (1997), used the Rotary groundnut kneader and was able to simplify the task and drudgery involved in groundnut oil extraction and also increase the oil produced as shown in Table 2.4 below. Comparison is made between the traditional pestle, IAR modified pestle and the developed mechanism.

Table 2.4 Comparative results of three groundnut oil extraction devices

Quantity of Groundnut (kg)	Efficiency range per tools (efficiency)		
	Traditional pestle	IAR Modified pestle	Developed Mechanism
2.2	0.6 – 0.8	0.1 – 0.7	0.6 – 0.7
4.4	0.6 – 0.7	0.5 – 0.7	0.5 – 0.9
6.6	0.5 – 0.7	0.4 – 0.7	0.6 – 0.7

Source: Sanda (1997)

Table 2.4 shows the advantage of the IAR modified pestle over the traditional pestle and the development mechanism (Sanda, 1997) over the IAR modified pestle.

Explanation for the slight variations in the oil extraction efficiencies with respect to different quantities could be linked with the following factors

1. Ability of tool to overcome increased motion resistance quantity of pastle

lesser quantity implies smaller motion resistance and hence thorough kneading and higher oil extraction.

2. Increased exhaustion rate on operators with increase in motion resistance of tool. This reduces the operator's ability to perform complete kneading in order to free oil entrapped in cake clots. Hence the reduction in extraction efficiency with increasing quantity.

2.4.2 Efforts Toward Increasing the Traditional Oil Extraction Processes in Nigeria

Various attempts have been made on the traditional system of groundnut oil extraction in Nigeria. Nalumansi and Kaul (1992) identified tasks as well as the key operations in the entire processing system. The authors observed that during the kneading operation, another person has to assists the person kneading by holding onto the mortar to keep it stable. The reason for extra support is due the fact the groundnut paste becomes hardened during the process, hence causing the mortar to be unstable. Studies on the motions of traditional method of kneading led to the development of an improved mechanism (IAR modified pestle) by Nanmansi and Kaul (1992). An improvement over the IAR modified pestle was carried only by Sanda (1997).

A model hydraulic press for oil extraction was also developed by Eke *et al* (1988). The authors reported that the machine could extract oil from several oil seeds, even though it was basically designed and constructed for extracting oil from beniseed. Experimental test results on the model hydraulic press showed some performance constraints. Eke *et al* (1988) discovered that the hydraulic jack component of the press could not generate the expected high pressure required for completely pressed out of the meal when the press cylinder was filled up. It was also reported that, there was presence of suspended materials in the extracted oil which had to be sedimented and the oil decanted.

Makanjuola (1997), developed a model machine, the screw press type for the extraction of oil from Soya bean which could also be used for other vegetable oil seeds including groundnut. Makanjuola discovered that after the test, it was observed that when the temperature was at $60^{o}c$ percentage of oil extracted was higher than that of room temperature.

This shows that the higher the temperature of the fried soya bean paste the higher the percentage of oil extracted.

2.4.3 Advantages and Disadvantages of Traditional Systems of oil extraction

The following advantages were reported by Nalumansi and Kaul (1992).

(i). The entire operations can be done within a defined enclosure.

(ii). The only expenditure is on the purchase of groundnut and firewood (to some extent).

The disadvantages of the traditional system were reported by several authors (Nalumansi and Kaul, 1992. Dunmade 1991, UNIFEM, 1989) as follows:

(i). Operations are done with heavy drudgery of roasting which usually takes too long to complete.

(ii). The kneading operation done manually is strenuous and also takes a longer time, usually requiring more labour.

(iii). There is normally no consistency in the degree of roasting which usually takes too long to complete.

(iv). The oil extraction in usually left incomplete due to the high drudgery involved.

(v). There is normally no proper means of regulating heat for those operations which require heating

Groundnut oil processing involves three major stages, which are;

(i) Pre-treatment: namely, the stages prior to the extraction stage such as cleaning, crushing and scorching.

(ii) Extraction: his stage involves the separation of the raw material into oil and residue (cake).

(iii) Post extraction treatments: comprising the packaging of the oil and cake for marketing. Oil refining, common in large- scale production.

2.5 Mechanical Oil Extraction Methods.

Extraction methods include:

- Manual presses
- Ghani
- Expeller
- Ram press (Ward, 1976)

2.5.1 Manual method

`Oil can be extracted by pressing softer oilseeds and nuts, such as groundnuts and Shea nuts, whereas harder, more fibrous materials such as copra and sunflower seed can be processed using ghanis. Pulped or ground material is loaded into a manual or hydraulic press to squeeze out the oil-water emulsion. This is more efficient at removing oil than traditional hand squeezing, allowing higher production rates.

2.5.2 Equipment required

The equipment needed to set up a small or medium scale oil extraction enterprise fall into four main categories: (Sanda, 1997)

- Pre-extraction equipment; dehullers or decorticators, seed/kernel crackers, roasters, grinding mills.

- Extraction equipment; ghani, manual bridge press or ram press, expellers
- Equipment for basic refining of oil; filters, settling tanks for caustic soda to treat free fatty acids FFA (do not use aluminium tanks).

Packaging equipment

The specific equipment required will depend on the particular crop being processed, the final oil quality required and the scale of operation.

2.5.3 Ram Press

Presses have a number of different designs, commonly based on a bridge press. In all types, a batch or raw material is placed in a heavy perforated metal 'cage' and pressed by the movement of a plunger.

The amount of material in the cage varies from 5-30kg with an average of 20kg. layer plates can be used in large cages to provide a constant pressure through the bulk of material and speed up removal of oil. The pressure should be increased slowly to allow time for the oil to escape. Screw types are more reliable than hydraulic types but are slower and produce less pressure. Except where a lorry jack is used, hydraulic types require more maintenance, and risk contaminating oil with poisonous hydraulic fluid. (Ward, 1976)

A long pivot lever moves a piston backwards and forwards inside a cylindrical cage constructed from metal bars spaced to allow the passage of oil. At one end of the piston's stroke, it opens an entry port from the seed hopper so that seed enters the press cage.

When the piston is moved forward, the entry port is closed and the oilseed is compressed in the cage. As a result, oil is expelled from the oilseed and emerges through the gaps in the cage. Compressed seed is pushed out through a circular gap at the end of the cage.

2.5.4 Ghani

Ghanis are widely used in Asia but less so in other areas. A heavy either wooden or metal pestle is driven inside a large metal or wooden mortar. The batch or raw material is grinded and pressed and the oil drains out. They have relatively high capital and maintenance costs and need skilled operators to achieve oil yields.

The ghani consist of large mortar and pestle, the mortar being fixed in the ground and the pestle being moved within the mortar by animal traction (donkey or mule) or (more commonly) a motor. Groundnut are placed in the mortar and the pestle grinds the material to remove the oil. The oil runs out of a hole in the bottom of mortar and the cake is scooped out by hand. This method is slow and requires two animals, replacing the tired one with another after 3-4 hours of work.(Nalumasi and Kaul, 1992).

Motorised ghanis are faster than manual or animal types but are more expensive than their higher capital and operating costs will require a large scale of production for profitability.

The width of this gap, which can be varied using an adjustable pressure cone, controls the operating pressure of the press. The design of the press is such that it can achieve operating pressure in excess of those obtained in most manually operated cage presses and as high as those in small expellers. The ram press has a low seed throughput but has the advantage of continuous operation. The ram press was developed in Tanzania specifically for processing a thin shelled high oil content variety of sunflower seed. The technique can be also be used for copra, groundnuts and sesame.

2.5.5 Expeller

An expeller consists of a helical thread (worm assembly) which revolves concentrically within a perforated cylinder (the cage or barrel). The barrel is usually formed by a series of axially-placed lining bars contained within a robust frame.(Goodrum and Bradly, 1985)

Heated groundnut seeds enter one end of the barrel through the feed inlet and are conveyed by the rotation worm assembly to the discharge end. With any power-driven equipment, it is important to consider how the equipment will be repaired as it becomes worn. Local refurbishment is normally cheaper than importing spare parts.(Goodrum and Bradly, 1985)

2.6 Roasting of Groundnut

In developing countries and some areas of the developed world, roasting of groundnut is still done by traditional method. In this method, firewood is used as source of fuel that provides the heat for roasting of the seeds. Most farmers still adopt the crude method of roasting which affect the quality and quantity of oil produced as well as burning the kernels and destruction of oil cells. The colour of the oil produced is also affected by time duration of roasting and temperature at which the seeds are roasted.

During roasting, amino acids and carbohydrates react to produce tetra hydrofuran derivatives which also dried the groundnuts further, causing them to turn brown as groundnut oil stains the cell walls. Following roasting, groundnuts are prepared for packaging or further processing into candies, peanut butter or groundnut oil. (Sharma, 1997)

2.6.1 Methods for Roasting Groundnut

There are two primary methods of roasting groundnut, they are;

- ▶Dry roasting
- ▶Oil roasting

Dry roasting is either a batch or continuous process. Batch roasters offer the advantage of adjusting for different moisture contents of groundnut lots from storage. Batch roaster is typically natural gas-fired revolving ovens (drums-shaped). The rotation of the oven continuously stirs the groundnut to produce an even roast. Oven temperatures are approximately

430°C (800°F) and groundnut temperature is raised to approximately 160°C (320°F) for 40 to 60 minutes. Actual roasting temperatures and times vary with the condition of the groundnut batch and the desired end characteristics. Continuous roasting reduces labour, ensures a steady flow of groundnut for other processes such as oil expelling, and decreases spillage. Continuous roasters may move groundnuts through an oven on a conveyor or by gravity feed. In another type of roaster, groundnuts are fed by a conveyor into a stream of counter current hot air that roasts the groundnuts. In this system, the groundnuts are agitated to ensure that air passes around the individual kernels to promote an even roast. (Gerald, 2009).

2.6.2 Pulsed Infrared Roasting

The application of high intensity pulsed infrared radiation for roasting groundnut results in optimum product quality in terms of colour, texture and free acid content. This method of roasting yields increased oil compared to previous methods as well as better oil quality. However, the cost of setting up a pulsed infrared roaster is exorbitant (Shankarappa et al.,)

2.6.3 Drum Roasting

The apparatus is basically a manually operated rotating drum that is heated externally. The structure is housed in a brick and clay construction (similar to a small-scale bakery oven). From the study of research, the continuous rotation of the drum throughout the process results in uniformly roasted groundnut. The drum roaster consists of two drums. The outer drum is fitted to the brick work. The inner drum is made in form of a drawer that is detachable for loading and unloading the groundnut (F.A.O., 1990)

2.7 Roaster for the oil expeller

The method of roasting of the groundnut seeds for the project under review will be on the principle of energy transfer through conduction and radiation.

The roaster will be made up of electric element with power rating at 1800watt, 240v; 50Hz.The heating element will be beneath the roasting tray conducting heat upward through it by conduction and radiation. The roasting tray will have an electric motor vibrator attached to it to agitate the groundnut for efficient roasting and free fall into the expelling unit.

These components will be sized together and properly insulated to minimize heat lost to the surrounding with higher efficiency.

CHAPTER THREE

3.0 Materials and Methods

The toasting unit consists of the hopper, conveyor tray, vibrator motor, cabinet (casing) and lagging materials, bearings, heating filament, frame, and exhaust. The hopper serves as an inlet for the roaster; it is to accommodate oil seeds before being transferred into the roaster. The conveyor trays are incorporated in the heating chamber with a vibrator motor attached to it. The continuous roaster moves groundnut through the heating chamber on a conveyor tray by gravity. In this system, the groundnut is agitated to ensure that air passes the individual kernels to promote an even roast. The downhill movement of groundnut is due to the force of gravity and is resisted by friction. The forces of gravity and friction are in balance at the angle of repose which is the maximum slope angle that unconsolidated materials can maintain.

3.1 Design Features of Roasting Unit

3.1.1 Hopper

The hopper serves the purpose of feeding the groundnut into the machine. It has dimensions of 180mm by 200mm at the top and 80mm by 120mm at the bottom, with a height of 200mm. The hopper is made of mild steel material.

3.1.2 Conveyor Trays

The conveyor trays are made of Aluminium sheet to enhance good heat conduction and resist corrosion. Each tray has a length of 600mm and a breadth of 150mm.

3.1.3 Casing

The casing has three openings in which one is for the hopper, another for the exhaust, and the third for the discharger. The casing houses the trays, vibrator, heating filaments with a dimension of height 650mm, a breadth of 300mm and a length of 700mm. It was lagged so as to reduce heat loss.

At the bottom of the casing is the collector channel for the exit of the roasted groundnut. The casing was made of mild steel to reduce heat loss.

3.1.4 Discharge Outlet

The discharge outlet is located at the base of the casing for the discharge of the roasted groundnut.

3.1.5 Lagging Materials

This serves the purpose of preventing heat loss to the environment. It helps to retain the temperature within the heating chamber. It is made of foam.

3.1.6 Springs

The springs are flexible supports which serve as a damper to allow flexible connection between the tray holder and the main body of the unit.

3.1.7 Vibrator Motor

The vibrator motor serves the purpose of agitating the groundnut as they are conveyed by the tray. This is to ensure that air passes through the individual kernels so as to promote an even roast. It has a small electric motor of 100Watts and an unbalanced mass of 1.4kg.

3.1.8 Heating Filament

This is located in the roasting chamber of the groundnut roaster. It serves the purpose of supplying the heat needed to roast the groundnut. It is made of composite material. A heating filament of 1800Watts was selected.

3.2 Design Calculations

3.2.1 Design of Hopper

The volume of the hopper can be calculated from the density and mass of groundnut.

Density of groundnut is 983.5kg/m^3 (Determined experimentally)

Mass of groundnut to be used is 3kg (Assumed)

Density $= \frac{mass}{volume}$ (Douglas, 2001)

Volume $= \frac{mass}{density}$

Volume $= \frac{3}{983.5} = 3.1\times 10^{-3} m^3$

If $3.1\times 10^{-3} m^3$ of groundnut is to be roasted in 30 minutes, therefore the expression of the machines capacity in volume per hour is

$C_{vph} = \frac{3.1\times10^{-3}\times60}{30} = 6.1 \times 10^{-3}\, m^3/h$

Similarly, the expression of the machines capacity in mass per hour is

$C_{mph} = 983.5 \times 6.1 \times 10^{-3} = 6.0\, kg/h$

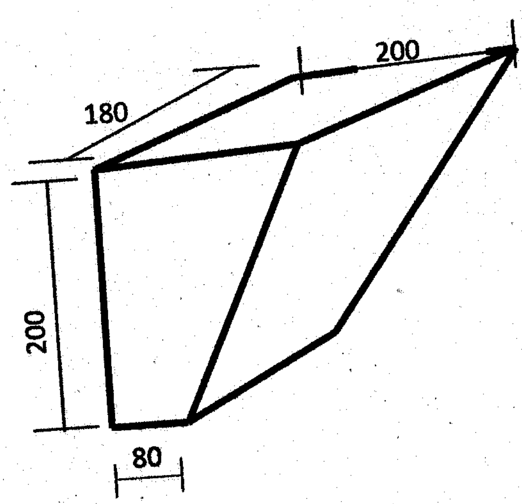
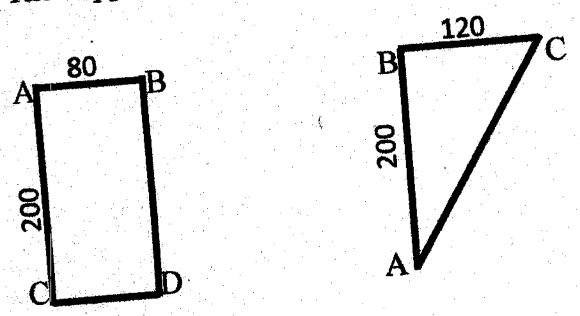


Figure 3.1 Hopper

The hopper is broken down into a rectangle and a triangle in order to calculate its volume.



Volume of hopper = (Surface Area of rectangle ABCD + Surface Area of triangle ABC) × width of hopper

Surface Area of rectangle = $l \times b$ (Adu, 2004)

Surface area = 200×80

Surface Area = $16000mm^2$

Surface Area of Triangle = $\frac{1}{2}bh$ (Adu, 2004)

Area= $\frac{1}{2}120 \times 80$

Area = $4800mm^2$

Volume of hopper = $(16000 + 4800) \times 180$

Volume of hopper = 20800×180

Volume of hopper = $3744000mm^3$

Volume of hopper = $0.0037m^3$

3.2.2 Heat Required for Roasting (Q)

The next step is to determine the power of the heating element that is required to roast the groundnut. Before this can be calculated, the quantity of heat required to roast the groundnut must be calculated.

$$Q = Mc\Delta T$$

$Q = Mc(T_2 - T_1)$ (Douglas, 2001)

Where Q = quantity of heat required (KJ)

M = Mass

C = specific heat

T_1 = Initial temperature

T_2 = Final temperature

M = 30Kg

C = Specific heat of air is 1.006KJ/kg/K. (Douglas, 2001)

T_1 = 30^0C (Initial temperature) assumed

T_2 = 90^0C (final temperature) assumed

Q = 30 x 1.006 x (90 – 30)

30 x 1.006 x 60

= 1810.8KJ.

Therefore, the quantity of heat required to roast the mass (30kg) of groundnut is 1,810.8KJ.

Since power is the rate at which work is done, therefore:

Power (kW) = $\frac{Work}{time}$ (Rajput, 1998)

If the groundnut is allowed for 20mins, then t = 20min

t = 20 x 60 = 1200 secs

$P = \frac{1810.8}{1200}$

= 1.509

= 1.5 KW

From the calculation above a heating filament of 1800Watts was selected to heat the groundnut.

3.2.3 Heat Loss

Some quantity/amount of heat is expected to be lost through the inner wall of the tank and the insulators to the environment, hence the heat loss is considered in the design.

$q = \frac{\Delta T}{\sum R_{thermal}}$ (Rajput, 1998)

Where q = heat transfer rate/energy transfer rate

ΔT = change in Temperature

$\sum R_{thermal}$ = total thermal resistances

Thermal resistance is

$R_{thermal} = \frac{x}{KA}$ (Rajput, 1998)

Where x is the thickness of the material

K is the thermal conductivity of the material

A is the area.

Assuming mild steel is used for the casing of the oven and foam is used for insulation.

Thermal conductivity (k) of mild steel = 42.9W/m^{0}C (Rajput, 1998)

Thermal conductivity of insulator = 0.04W/m^{0}C. (Rajput, 1998)

Assuming thickness of the mild steel used is 2mm,

A = $l \times b$ (Adu, 2004)

l = 700mm = 0.7m, b = 300mm = 0.3m

A = 0.7 × 0.3

A = 0.21m^2

$$R_{thermal} = \frac{2 \times 10^{-3}}{42.9 \times 0.21}$$

$R_{thermal} = 2.22 \times 10^{-4}$ °C/W

Assuming thickness of insulator is 25mm = $25 \times 10^{-3} m$

l = 675mm = 0.675m

b =275mm = 0.275m

A = 0.675× 0.275 = $0.19m^2$

$$R_{thermal} = \frac{25 \times 10^{-3}}{0.04 \times 0.19}$$

$R_{thermal} = 3.29\ °C/W$

Total thermal resistance = $2.22 \times 10^{-4} + 3.29 = 3.29022\ °C/W$

$\Delta T = (T_2 - T_1)$

T_2 = inside temperature of the oven = 120°C

T_1 = outside temperature of the envirosnment = 30°C

$\Delta T = 120 - 30 = 60°C$

$q = \frac{60}{3.29022}$

q = 18.24 W

3.2.4 Power Required to Vibrate Tray

Trays Vibrator frequency

Given that vibrator motor = 3,000 rpm

$\omega = \frac{2\pi N}{60}$ (Rajput, 1998)

$$\omega = \frac{2\pi \times 3000}{60} = 314.2 rad/sec$$

$f = \frac{\omega}{2\pi}$ (Rajput, 1998)

$f = \frac{314.2}{2\pi} = 50.01 Hz$

Pv = Power required to vibrate trays

$P_r = Mr\omega$ (Douglas, 2001)

Where

M= Vibrator mass = 1.4kg

r = radius of mass = 5cm = 0.05m

$P_r = 1.4 \times 0.05 \times 314.2$

$P_r = 22W$

3.2.5 Angle of Inclination of Conveyor Trays ($\emptyset_i$)

$\emptyset_i = \frac{\theta}{6}$ (Douglas, 2001)

$\theta = Angle\ of\ repose = 30^0$

$\emptyset_i = \frac{30}{6} = 5^o$

3.3 Spring Design Analysis

Two helical springs were fixed at the bottom of the roasting chamber to allow flexible connection between the tray holder and the main body of the unit. The strength of the steel used is one of the most important criteria to consider in designing springs. The following analysis was made using the methods from Hall et al, 1988, Spott M. F, 1988 and Rajput, R. K, 1998.

F= Load exerted on the spring = 50N (assumed)

Where;

C = Spring Index = D/d

d = Wire diameter (m)

D = Spring Diameter (m)

G = Modulus of Rigidity (N/m^2)

K_d = Traverse Shear Factor = (C+0.5)/C

K_w = Wahl's Factor = [(4C-1) / (4C+5)] + (0.615/C)

N = Number of coils

τ_{max} = Max Shear Stress(N/m^2)

$\delta =$ Deflection (mm)

Maximum working stress of the spring =1900MN/m^2 (Assumed)

The mean diameter of coil is 15 times that of the wire diameter (Assumed).

Diameters D and d;

$\tau = \frac{8FD}{\pi d^3}$ (Rajput, 1998)

$\tau = 1900M\,N/m^2$

F = 50N

D = 15d

$$1900 \times 10^6 = \frac{8 \times 50 \times 15 \times d}{\pi \times d^3}$$

$$d^2 = \frac{8 \times 50 \times 15}{\pi \times 1900 \times 10^6}$$

$d = 1.00 \times 10^{-3} m = 1mm$

$D = 15d = 15 \times 1 = 15mm$

3.3.1 Spring Index

The spring index (C) for helical springs is a measure of coil curvature.

$C = \frac{D}{d}$ (Rajput, 1998)

$C = \frac{15}{1} = 15$

3.3.2 Spring Constant

The spring constant K is a function of the spring geometry and the spring material's shear modulus G,

$G = 80 \times 10^9\ N/m^2$ (Rajput, 1998)

D = 15mm = 0.015m

d = 1mm = 0.001m, N = 10 coils

$K = \frac{Gd^4}{8D^3N}$ (Rajput, 1998)

$$K = \frac{80 \times 10^9 \times 0.001^4}{8 \times 0.015^3 \times 10}$$

$K = 296.3N/m$

3.3.3 Spring Deflection

$$\delta = \frac{8FD^3N}{d^4G} = \frac{8FC^3N}{dG}$$

$$\delta = \frac{8 \times 50 \times 15^3 \times 10}{1 \times 80 \times 10^9}$$

$$\delta = \frac{13500000}{8^{10}}$$

$$\delta = 1.69 \times 10^{-4} mm$$

3.3.4 Spring Stress Values

The study of literature revealed that for general purpose springs a maximum stress value of 40% of the steel tensile stress may be used (Spott, 1988). However, the stress levels are related to the duty and the material condition.

$\tau_{max} = \frac{8FD}{\pi d^3} \times K_d$ Also, (Hall et al, 1988)

$\tau_{max} = \frac{8FD}{\pi d^3} \times K_w$ (Hall et al, 1988)

$$K_d = \frac{C + 0.5}{C} = \frac{15.5}{15} = 1.033$$

$$K_w = [(4C - 1) / (4C + 5)] + (0.615/C)$$

$$K_w = \frac{4 \times 15 - 1}{4 \times 15 - 4} + \frac{0.165}{15} = 1.0426$$

Considering K_d (Traverse Shear Factor), maximum Shear stress is

$$\tau_{max} = \frac{8 \times 50 \times 0.0015 \times 1.033}{\pi \times 0.001^3}$$

$$\tau_{max} = 19728864.75 N/mm^2$$

$$\tau_{max} = 19.7 MN/m^2$$

A curvature correction factor has been determined (attributed to A.M Wahl). Considering this Wahl Factor (K_w), maximum shear stress is calculated thus,

$$\tau_{max} = \frac{8 \times 50 \times 0.015 \times 1.0426}{\pi \times 0.001^3}$$

$$\tau_{max} = 1991219324 \text{N}/mm^2 = 1991.2 \text{MN}/m^2$$

3.3.5 Spring Resonant Frequency

$$f_{res} = \frac{1}{2}\sqrt{\frac{\text{K}}{\text{M}}}$$ (Spott, 1988)

Where K is the spring constant from above and M is the spring mass (0.01Kg).

$$f_{res} = \frac{1}{2}\sqrt{\frac{296.3}{0.01}} = 86.07\text{Hz}$$

CHAPTER FOUR

4.0 Test, Results and Discussion of Results

4.1 Mode of Operation of the Machine

The groundnut roasting machine is electrically powered and the heat used in roasting the groundnut is produced by heating filament. The groundnut is fed into the machine through the hopper to the conveyor trays which transport the groundnut through the roaster. The groundnut spends 20 minutes travelling through the roaster at which the groundnut gets satisfactorily roasted and is discharged through the discharge outlet at the bottom of the casing.

4.2 Testing

After fabrication, the roasting unit and expelling unit was coupled. Performance test was carried out on the machine. This was aimed at assessing the performance and the degree to which the roaster could roast groundnut and the expeller could extract oil.

4.3 Determination of Efficiency

4.3.1 Roaster Efficiency

Total number of groundnut fed to the hopper (input) = 30Kg

Total number of groundnut completely roasted (output) = 20Kg

Total number of groundnut partially roasted = 10Kg

Efficiency = (output /input) × 100%

Efficiency = 66.7%

4.3.2 Oil Extraction Efficiency

$\frac{Q.E}{TQO} \times 100$

Q.E =Quantity of oil Extracted =6kg

TQO =Total quantity of oil in groundnut

20kg of roasted groundnut was fed into the expelling unit:

Total quantity of oil in 20kg= oil content in groundnut × 20kg

Oil content in groundnut = 45%

Total quantity of oil in 20kg = $\frac{45}{100} \times 20$

=9 kg

Efficiency = $\frac{6}{9} \times 100$ =66.7%

4.4 Discussion of Result

The machine gave an efficiency of 66.7%. This value of efficiency must have been due to heat lost by the heating element and velocity. The result of the velocity which was 8.33mm/s indicated that it is sufficiently required for the groundnut to travel in 20 minutes before it is completely roasted. Both the efficiency and the value of the velocity indicated that the machine is satisfactory for its minimum requirements.

4.4.1 The Quantity of Groundnut Roasted Per Time

30kg of groundnut was found to be roasted in 30minutes with 20kg of the groundnut properly roasted. This shows that the roaster posses' higher efficiency of roasting compared with the previous roaster that has 20% efficiency.

4.4.2 The Maximum Temperature Reached

The temperature achieved using 1800watt, 240v filament for the groundnut roaster was 120^{0}C as against 160^{0}C needed to roast groundnut for the purpose of oil extraction from the literature review.

4.4.3 Time Reduction

The groundnut roaster unit has a volume of $0.0037m^3$, heat quantity of 1810.8kJ and power rate of 1.5kw capacity. The capacity of the groundnut roasting unit was able to roast 30kg of the groundnut groundnut in 30minutes compared with crude method of roasting groundnut that takes between 1hr 30minutes to 2hrs to roast the same quantity of groundnut characterized with the use of fire wood as source of heat and also affected by time taken to set up the fire with the rate at which it burns. The quality of roasting differs with higher quality of roasting using roaster. It is attributed to good material handling offered by the machine while the local method is characterised by poor material handling.

4.4.4 Labour Reduction

The labour demand by the local method of groundnut roasting was reduced by the machine as only one person is required to operate the machine, hence justifying the objectives of the research work.

4.5 Cost Analysis

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

- Material cost
- Labour Cost
- Overhead Cost

4.5.1 Direct Material Cost

Direct material cost is the cost of the materials that can be identified in the finished product. The cost estimates of the materials used for the fabrication of the roaster are tabulated in table 4.1

Table 4.1 Material Cost

S/N	DESCRIPTION	QTY	UNIT COST	TOTAL COST
1	Electric Motor	1	12,000	12, 000
2	Gear Box	1	6,000	6, 000
3	Auger	-	2,200	2, 200
4	Oil Extractor Barrel	-	1,200	1, 200
5	Bolt & Nut	10	20	200
6	Control Lever	1	750	750
7	Support Frame	1	3,000	3, 000
8	Spring	4	150	600
9	Vibrator	1	3,250	3, 250
10	Heating Filament	1	1,300	1, 300
11	Aluminium Sheets	-	3,850	3, 850
12	Exhaust	1	500	500
13	Hopper	1	800	800
14	Rivets	10	60	600
15	Square pipe	3	1,500	4,500
16	Mild Steel Sheet	2	3,500	7,000
17	Paint	1 tin	1,500	1, 500
18	Foam (Insulator)	1 sheet	2,300	2.300
19	Plugs	3 Pieces	300	900
20	Cable	8 Yards	100	800
21	Thinner	3 Tins	250	750
	Total			54,000

Material Cost = ₦54, 000

4.5.2 Direct Labour Cost

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

40% of 54,000 = ₦21, 600

4.5.3 Overhead Cost

This is the total cost of fabricating the product which cannot be identified in the project. The overhead cost was ₦9,400

4.5.4 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 4.2 Total Cost Estimate

Description	Cost
Direct Material Cost	54,000
Labour Cost	21,600
Overhead Cost	9,400
Total Cost	85,000

CHAPTER FIVE

5.0 Conclusion and Recommendations

5.1 Conclusion

The unit operations involved in extracting groundnut oil was combined; these are the roasting and expelling units. The roasting unit is made up of a heating filament of 1800watts, a vibrator motor of 100watts with an unbalanced mass of 1.4kg, conveyor trays made of aluminium and a discharge outlet that passes the roasted groundnut to the expelling unit. The expelling unit on the other hand is made up of the control lever; the auger, the gear box which is connected to a pulley and also an electric motor interconnected by a vee-belt for the transfer of motion. Performance test was carried out on the fabricated machine. An efficiency of 66.7% was obtained in both the roasting and expelling units respectively. However, there was a loss of heat through the walls of the roaster and leakage in the expelling unit. If the machine is properly handled, it is a great prospect to our growing economy, thereby making roasting of groundnut as well as extraction of the oil less tedious.

It can be concluded that the performance of the fabricated machine is satisfactory as accessed from the result obtained.

5.2 Recommendations

i. An interface should be designed between the roasting and expelling unit so as to check the roasted groundnut.

ii. The efficiency can be improved upon by proper adjustment of the angle of repose of the roasting trays.

iii. Thermometer and temperature regulator should be used to control the heat.

iv. Pyrex glass can be used in both sides of the roaster to monitor roasting of the seeds.

REFERENCE

Adu, J. M. (2004): *"Comprehensive Mathematics for Senior Secondary School"s*, Johnson Publishing limited, lagos, Nigeria.

Asiedu, J. J. (1988): *Processing Tropical Crops, a technological approach*, London Macmillan press.

Douglas, J. F. (2001): *Fluid Mechanics*, Longman Imprint, England.

Food and Agriculture Organization (F.A.O), 1990

Gerald, L. (2009): *The Application of Fluid mixers in edible oil processing*. Available at: Www. emimixers.com

G. O. I. Abalu and E. G. Etuk (1986) Traditional versus improved Groundnut production practices institute for Agricultural research, Ahmadu Bello University Zaria vol. 22 pp33-38, university press Ltd.

Hall, A. S. & Laughlin, H. G. (1988): *Machine design (Theory and Problems)*, Schaum's Outline Series.

Hammos, R. O. (1994): *"The origin and History of groundnut"* In: Smartt, J. (Ed), the Groundnut crop; A scientific Basis for Improvement, Chapman and Hall, New York, U.S.A

Hans, J.W & Frans, W. K. (1989) *"Small Scale processing of oil Fruits and Oil seeds"* Publication of German Appropriate Technology Exchange (GATE), D-65726, Eschborn, Federal Republic of Germany.

Jambunathan, R (1991): Groundnut quality, *Characteristics uses of tropical Grain Legumes*, Krista Center, India

Jasper G. W. (1983): *Peanuts production, processing, products*, Avi Publishing Company Westport.

Kordylas, (1990) Processing and preservation of tropical and sub tropical foods Macmillam publishing company Ltd. Pages (153-154)

Makanjoula, E. O. (1997). Fabrication of screw press for extraction of soya bean oil. National deploma report submitted to the department of Agric. Mech. Samaru college of Agriculture, A. B. U., Zaria.

Nalumansi, S. R. And R. N. Kaul (1992): Studies on the traditional system of groundnut oil extraction and possible improvement – part of research findings under the IAR-Ford Foundation project on Tech. for women Agric mechanisation Res. Prog., IAR, A. B. U. Samaru Zaria.

Rajput, R. K. (1998): *Strength of Materials*, S. Chand and Company Limited, New-Delhi, India

Shankarappa, T., Robert, E. R. and Virginia, N. (2003): *"World Geography of groundnut, Destribution, Production Use and Trade"* Available at: http://www.lanra.anthro.uga.edu/peanut/knowledge

Spott, M. F. (1988): *Design of Machine Elements*, prentice hall of India Limited, New Delhi India.

United Nation Industrial development Organization (UNIDO), (1976): Proceeding of world Conference on oil seeds and vegetable oil processing Technology UNIDO edition www.appropedia.org www.icar.org.in

Sharma, K. D. (1977): Biochemical changes in stored oil seeds. Indian J. Agric. Res. 11(3): 137-141.

Sivakumaran, K. J. W. Goodrum and A. R. Bradley (1985): Expeller Optimization for Peanut Oil Production. Trancsaction of the ASAE., 28(1): 316-20

Ward, J. A. (1976): Processing High Oil content seeds in continue screw press. J. Am. Oil Chem. Soc. 53(6): 261-4.

APPENDIX

1.0 DETERMINATION OF DENSITY OF GROUNDNUT

EXPERIMENT (1)

Weight of empty beaker: W° =27.70g

Weight of beaker + groundnut: W =62.45g

Weight of groundnut: W – W =W= 34.75g =3.475×2Kg

Volume of water in measuring cylinder = 50ml

New Volume of water dropping groundnut = 85ml

Volume of water displaced = 35.0ml = $3.5 \times 10^{-2} L = 3.5 \times 10^{-5} m^3$

Therefore,

Density of groundnut = $\frac{mass}{volume} = \frac{3.475 \times 10^{-2}}{3.5 \times 10^{-5}}$

Therefore, $D_2 = 922.86 Kg/m^3$

EXPERIMENT (2)

Weight of empty beaker; $W^0 = 27.70g$

Weight of beaker + groundnut; $W_3 = 54.97g$

Weight of groundnut; $W_3 - W_0 = W_4 = 27.27g = 2.727 \times 10^{-2}kg$

Volume of water in measuring cylinder = 50ml

New volume of water after dropping groundnut = 78ml

Volume of water displaced = 28ml = $2.8 \times 10^{-2} m^3$

Therefore,

Density of groundnut = $\frac{mass}{Volume} = \frac{2.77 \times 10^{-2}}{2.8 \times 10^{-5}}$

$D_2 = 973.93 kg/m^3$

The average density of groundnut is $\frac{D_1 + D_2}{2} = \frac{992.86+973.93}{2}$

$= 983.4 kg/m^3$

2.0 DETERMINATION OF DENSITY GROUNDNUT OIL

EXPERIMENT

Weight of empty beaker; $W_0 = 27.70$g

Weight of beaker + groundnut oil; $W_5 = 64.23$g

Weight of groundnut oil; $W_5 - W_0 = W_6 = 36.53 = 3.653 \times 10^{-2}$kg

Volume of water in measuring cylinder = 50ml

The volume of groundnut oil in the beaker was 40ml = 40×10^{-2} litres = $4 \times 10^{-5}m^3$

$$\text{Density} = \frac{mass}{volume} = \frac{3.653 \times 10^{-2}}{4 \times 10^{-5}}$$

$$= 913.35 kg/m^3$$

3.0 DETERMINATION OF THE MOISTURE CONTENT OF THE GROUNDNUT

The initial moisture content of the groundnut was determined as follows. Some quantity of the groundnut was weighed and roasted in the roaster for 30minutes.After it was found that there was no further change in weight (i.e. weight remained constant) the groundnut removed was determined as follows;

BEFORE ROASTING

Weight of can, $W_1 = 0.50$kg

Weight of can + groundnut, $W_2 = 0.61$kg

Weight of groundnut, $W_3 = 0.11$kg

AFTER ROASTING; (30 minutes at 90^{0}c)

Weight of can + groundnut, $W_4 = 0.59$kg

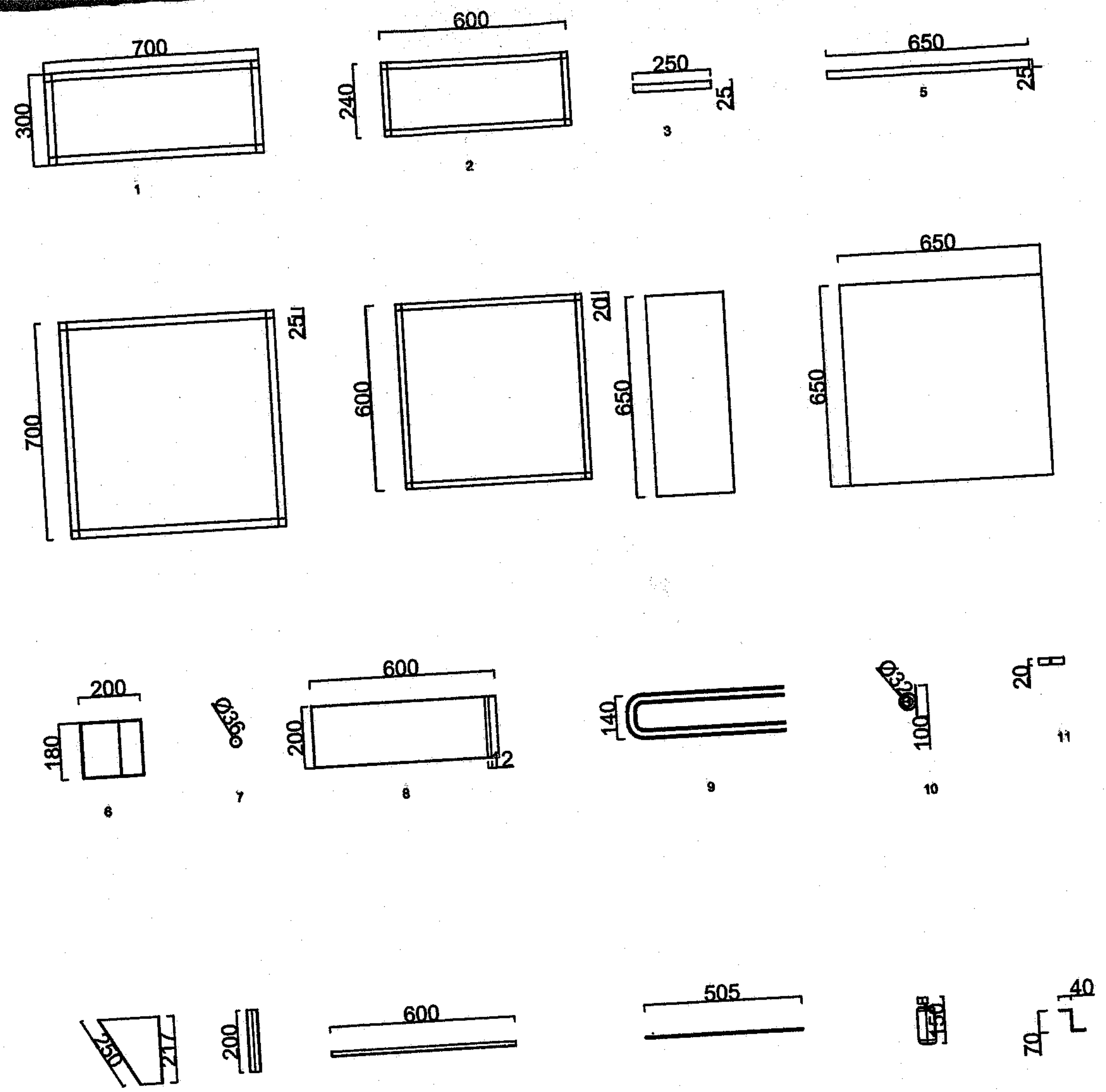
Weight of groundnut, $W_5 = 0.09$kg

Therefore,

$$\text{Moisture content} = \frac{W_3 - W_5}{W_3} \times 100\%$$

$$= \frac{0.11 - 0.09}{0.11} = 18.2\%$$

That is, the initial groundnut moisture before drying operation was found to be 18.2%. Then the moisture content was removed by roasting in batches through a continuous process for 30 minutes at 90^0c. On the average, from these calculations, the moisture removed was 7%. Therefore, the actual moisture content of the groundnut used in the test was found to be 11.2%

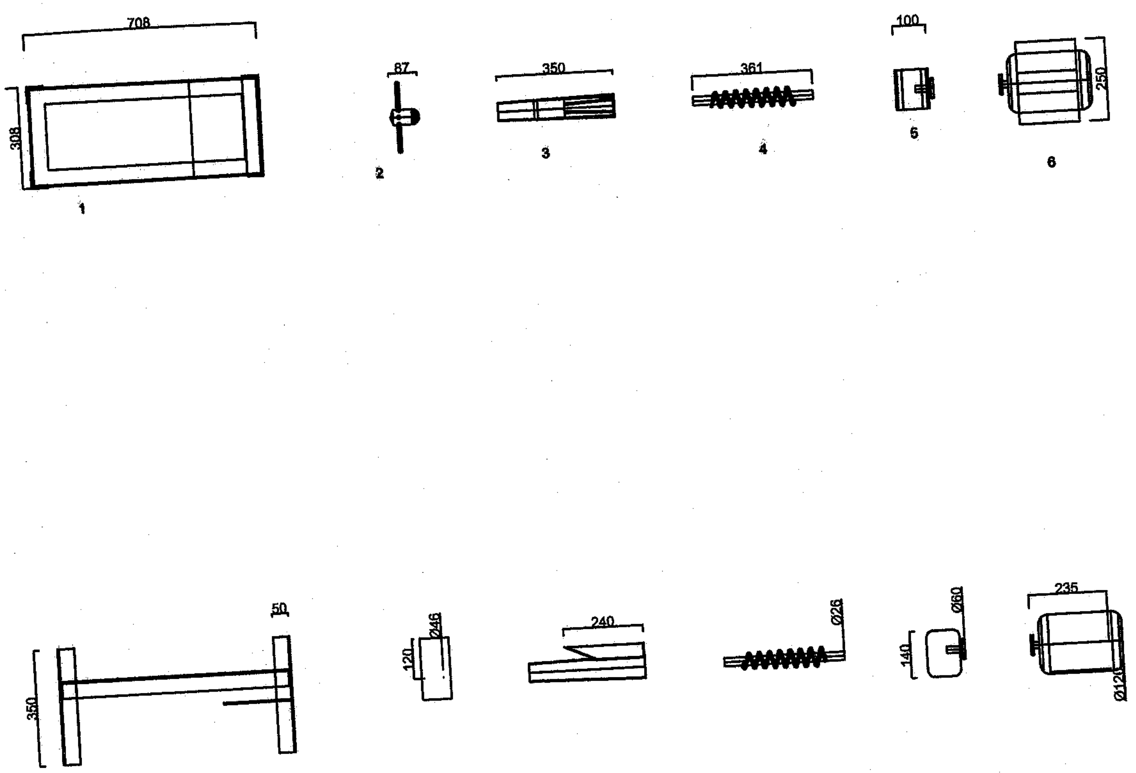


S/N	PART NAME	MATERIAL
10	FLEXIBLE SUPPORT BAR	MILD STEEL
9	VIBRATOR	COMPOSITE
8	HEATING FILAMENT	COMPOSITE
7	ROASTER TRAY	ALUMINIUM
6	ROASTER EXHAUST	MILD STEEL
5	ROASTER CHAMBER HOPPER	MILD STEEL
4	ROASTER FRAME FRONT COVER	MILD STEEL
3	ROASTER FRAME SIDE COVER	MILD STEEL
2	ROASTER FRAME HOLDER	MILD STEEL
1	ROASTER FRAME	MILD STEEL

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

DEPARTMENT OF AGRICULTURAL AND BIORESOURCES ENGINEERING

REG NO:	2006/24064EA	SIGN	ALL DRAWINGS IN MILLIMETERS
NAME:	OLAKUNLE LEMAH		
DRAWN BY:	-DO-		
SUPERVISOR:	ENGR. DR. PETER IDAH		
TITLE:	PART DRAWING OF GROUNDNUT OIL EXPELLER	DATE	NOVEMBER, 2011

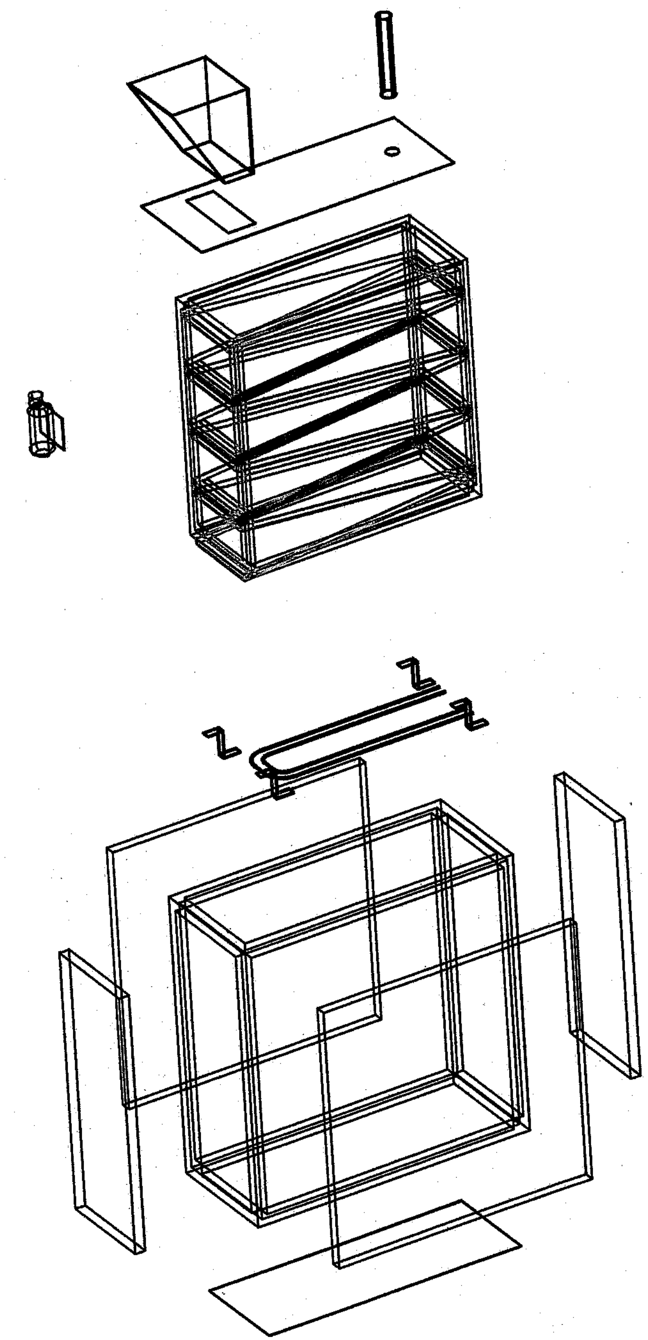


S/N	PART NAME	MATERIAL
6	ELECTRIC MOTOR	COMPOSITE
5	GEAR BOX	STEEL
4	AUGER	MILD STEEL
3	OIL EXTRACTOR BARREL	MILD STEEL
2	CONTROL LEVER	MILD STEEL
1	OIL EXTRACTOR SUPPORT FRAME	MILD STEEL

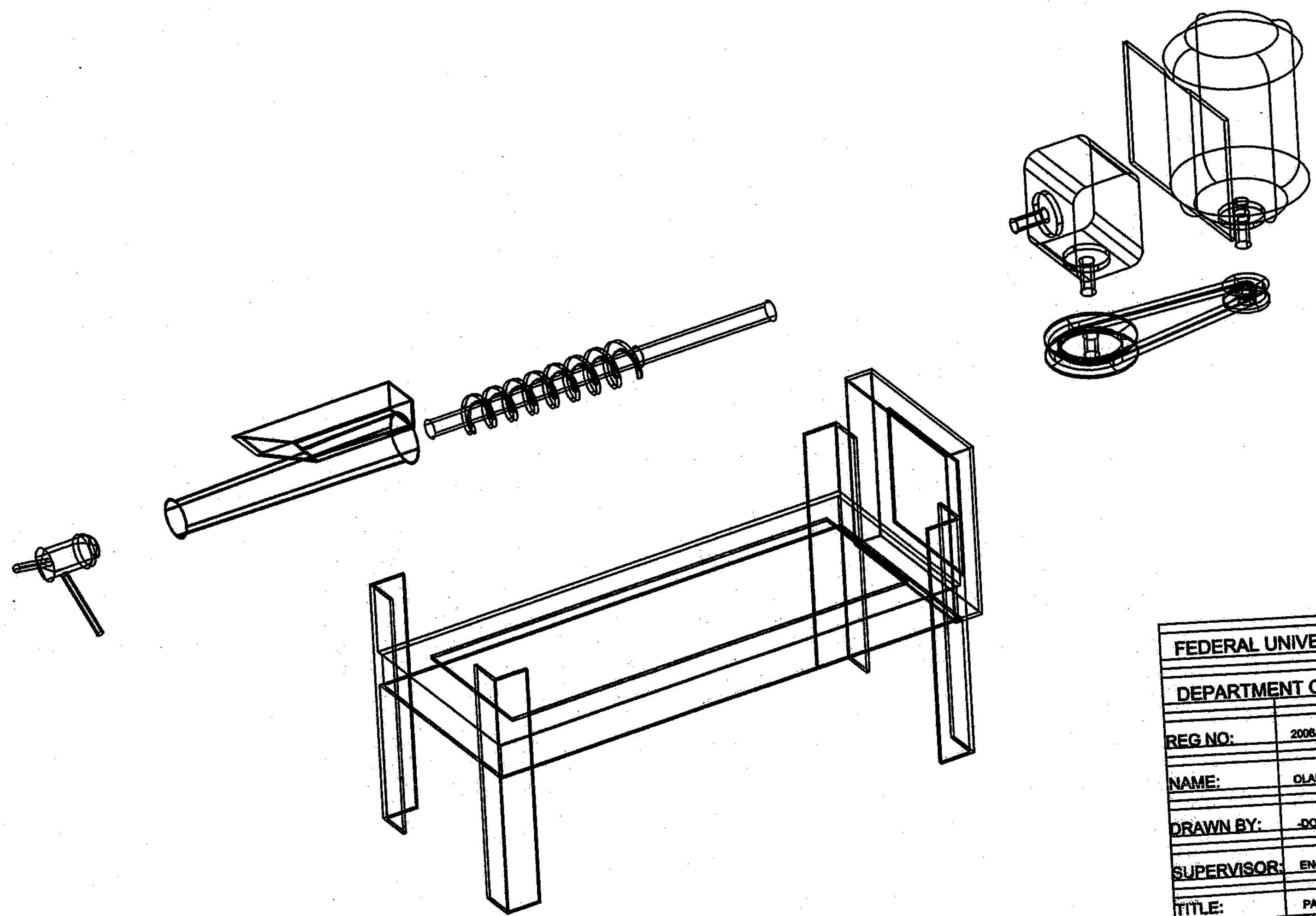
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

DEPARTMENT OF AGRICULTURAL AND BIORESOURCES ENGINEERING

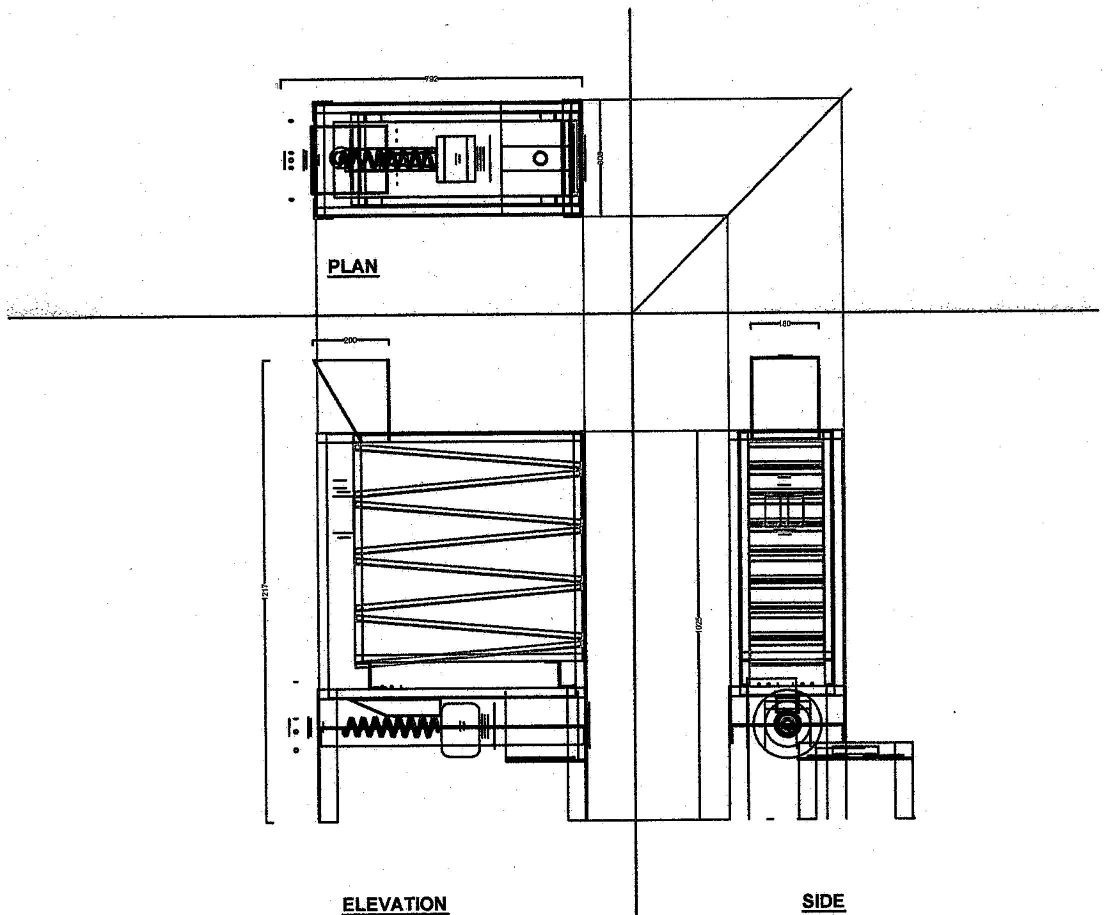
		SIGN	ALL DRAWINGS IN MILLIMETERS
REG NO:	2006/24064EA		
NAME:	OLAKUNLE LEMAH		
DRAWN BY:	-DO-		
SUPERVISOR:	ENGR. DR. PETER IDAH		
TITLE:	PART DRAWING OF GROUNDNUT OIL EXPELLER	DATE	NOVEMBER, 2011



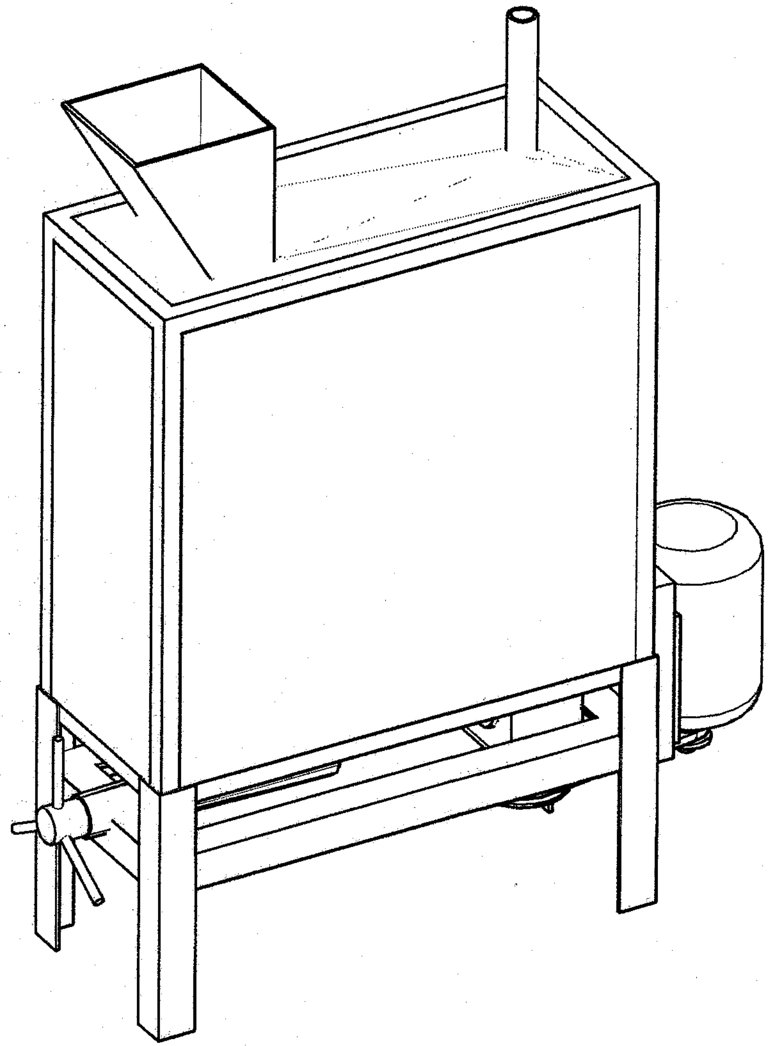
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA			
DEPARTMENT OF AGRICULTURAL AND BIORESOURCES ENGINEERINC			
		SIGN	ALL DRAWINGS IN MILLIMETERS
REG NO:	2008/24064EA		
NAME:	OLAKUNLE LEMAH		
DRAWN BY:	-DO-		
SUPERVISOR:	ENGR. DR. PETER IDAH		
TITLE:	PART DRAWING OF GROUNDNUT OIL EXPELLER	DATE	NOVEMBER, 2011



FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA			
DEPARTMENT OF AGRICULTURAL AND BIORESOURCES ENGINEERING			
			ALL DRAWINGS IN MILLIMETERS
REG NO:	2006/24064EA		
NAME:	OLAKUNLE LEMAH	SIGN	
DRAWN BY:	-DO-		
SUPERVISOR:	ENGR. DR. PETER IDAH		
TITLE:	PART DRAWING OF GROUNDNUT OIL EXPELLER	DATE	NOVEMBER, 2011



FEDERAL UNIVERSITY OF TECHNOLOGY MINNA		
DEPARTMENT AGRICULTURAL AND BIORESOURCES ENGINEERING		
REG NO:	2006/24064EA	ALL DRAWINGS ARE IN MILLIMETER
NAME:	OLAKUNLE LEMAH	SIGN
DRAWN BY:	-DO-	3rd angle projection
SUPERVISOR::	ENGR DR PETER IDAH	DATE
TITLE	PART DRAWING OF GROUNDNUT OIL EXPELLER	NOV 2011



FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA			
DEPARTMENT OF AGRICULTURAL AND BIORESOURCES ENGINEERING			
REG NO:	[illegible]		ALL DRAWINGS IN MILLIMETERS
NAME:	OLAKUNLE USMAN	SIGN	
DRAWN BY:	-DO-		
SUPERVISOR:	ENGR. DR. PETER IDAH		
TITLE:	PART DRAWING OF GROUNDNUT OIL EXPELLER	DATE	NOVEMBER, 2011