DESIGN AND CONSTRUCTION OF A COCONUT OIL EXPELLER

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BEING A PROJECT WORK SUBMITTED TO THE DEPARTMENT OF MECHANICAL ENGINEERING, SCHOOL OF ENGINEERING, AUCHI POLYTECHNIC, AUCHI.

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CERTIFICATION

We the undersigned certify that this project work titled **"DESIGN AND CONSTRUCTION OF A COCONUT OIL EXPELLER**" was carried out by:

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DEDICATION

This project is dedicated to the God Almighty.

ACKNOWLEDGEMENT

We thank God Almighty for his grace, mercy and guidance upon our live for his inspiration given to us towards the success of this project work.

With sincere gratitude, we wish to thank our project supervisor **Mr. Arewa I.** for his moral and fatherly support, assistance and kindness towards the success of this project work. We also wish to extend our gratitude to the head of Department, **Engr. Aslem Akhigbe** and all the lecturers in the Department of Mechanical Engineering, School of Engineering. We say may God in his infinite mercy bless you all, Amen.

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ABSTRACT

Coconut oil is one of the important oil used by many societies as its uses ranges from cooking and recipes, for hair treatment, for better health state, body beautification and for natural remedies. Getting coconut oil from coconut meat or copra has been one of the challenges faced by consumers of coconut oil; the traditional method which involves the use of wood to heat up the copra is hazardous to health as it produces smoke and requires more time and energy to produce. This project work targets at the design and construction of a coconut expeller using the locally available materials, the design is aimed at overcoming the problems associated with the traditional method of extracting the coconut oil. This project work also covers the design methodology, material selection, production cost as well as design drawing for components and also the assembly drawing. From performance evaluation the expeller is capable of producing 1.065kg of oil from 2kg of copra with 7.2% moisture content. It concludes by advancing some recommendation for further work.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The Coconut (*cocos nucifera)* is known for its great versatility, as evidenced by many traditional uses, ranging from food to cosmetics. They form a regular part of diets of many people in the tropics and subtropics. Coconuts are distinct from many other fruits for their large quantity of water and when immature, they are known as jelly nuts and may be harvested for their portable coconut water. When mature, they still contain some water and can be used as seed nutsy or processed to give oil from the kernel, charcoal from the hard shell and coir from the fibrous husk (Geber-Stock, 2015).

Coconut oil or copra oil is an edible oil extracted from the kernel or meat of mature coconuts harvested from the coconut palm. It is edible oil that has been consumed in tropical places for thousands of years. Studies done on native diets high in coconut oil consumption show that these populations are generally in good health and do not suffer as much as from many of the modern diseases of western nations where coconut oil is seldom consumed anymore.

Coconut oil is nature's richest source of lauric acid. Coconut oil was once prevalent in western countries like the United States. With a long shelf life and a melting point of 76 degrees, coconut oil was a favorite in the baking industry but a negative campaign against saturated fats in general, and coconut oil in particular, led to most food manufacturers abandoning coconut oil in recent years in favor of hydrogenated polyunsaturated oils that come from the main government-subsidized cash crops in the US, particularly corn and soy. Back in the 1930s, a dentist named Dr. Weston Price traveled throughout the South Pacific, examining traditional diets and their effect on dental and overall health. He found that those eating diets high in coconut products were healthy and trim, despite the high fat concentration in their diet. Similarly, in 1981, researchers studied populations of two Polynesian atolls. Coconut was the chief source of caloric energy in both groups. The results, published in the American Journal of Clinical Nutrition, found no evidence that the high saturated fat intake had a harmful effect in these populations (Essiamah, 2012).

Coconut oil is made from the fruits of coconut palm trees, which grow in hot, rainy tropical climates. There are two main types of coconut oil: refined and virgin. Refined coconut oil is made of copra, coconut meat that has-been scraped out of ripe coconuts and dried for several days in the sun or in kiln. The refining process strips away some nutrients and makes the coconut flavor much less pronounced. Refined coconut oil has higher smoke point (365degrees), which makes it abettor option for higher heat cooking and baking. Virgin coconut oil is from fresh coconuts, not copra (Dayrit, 2005).The coconut flavor is much more pronounced, and it has a lower smoke point (280degrees), so it’s more appropriate for no-cook or no bake recipes, or light sautéing in dishes where its coconut flavor will enhance the recipe. You may also see organic coconut oil, meaning it is made from certified organic coconuts, or the Fair Trade label, which means the coconuts were grown in conditions that take into account worker conditions, environmental impact and faircompensation for everyone in the supply chain. Coconut oil has a melting point of 78 degrees, warmer than that and the substance illiquid; when it is stored at cooler temperatures, including in your refrigerator, it's solid.

Coconut oil contains several different types of saturated fatty acids including lauric, muriatic, politic andcaprylic acids. Virgin coconut oil contains the most lauric acid (Cornelius, 1973). They fall into a special class of fatty acids known as medium-chain triglycerides(MCTs). Unlike long-chain triglycerides, MCTs are metabolized faster than their longer counterparts. While the MCTs in the tropical oilpaper to boost HDL (the "good "cholesterol), they also raise LDL (the "bad" cholesterol). Coconut oil —especially the virgin type with lauric acid — can be used in moderation as you would any fat.

1.2 STATEMENTOF THE PROBLEM

In the traditional methods of oil extraction from coconut, almost all the stages involved are manual and labour intensive. The processing stages are therefore, strenuous, arduous, tiring, time consuming and particularly inefficient. Also, some of the operations have been reported to be hazardous to human health. The crude nature of the processing procedures, no doubt affects both the quantity and quality of oil recovered at the end. This is as a result of the inefficiency of the traditional methods and techniques. Often times a certain percentage of the oil extracted is found containing some quantity of free fatty acid, water, etc, resulting from the chemical breakdown of oil giving it unpalatable flavour

1.3 AIM AND OBJECTIVES

1.3.1 AIM

The aim of this project is to design and construct a coconut oil expeller that requires less human effort to operate.

1.3.2 OBJECTIVES

The objectives of this project work are:

a) Making oil extraction and expelling operation easy, simple and time conserved.
b) Reducing high investment on coconut oil expelling.
c) Making coconut oil expelling machines easy to use.

1.4 SIGNIFICANCE OF THE STUDY

This project work is to provide information about the importance and commercial uses of Coconut oil and to design and construct a Coconut Oil Expeller Machine putting cost and safety into consideration.

1.5 SCOPE OF THE STUDY

The research work covers feasibility study, scouting and acquisition of the necessary raw materials required for the production and formulations of coconut oil. Other areas, analytical test of the coconut oil expeller machine and product quality.

This project work does not go beyond the research about coconut, coconut oil and the design and construction of a coconut oil expeller machine.

1.6 DEFINITION OF TERMS

- **Hopper:** A hopper is a funnel-shaped container from which solid materials can be emptied into a container below (Collins Dictionary)
- **Bearing:** A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. (From Wikipedia)
- **Expeller Pressing:** This is a mechanical method for extracting oil from raw materials. The raw materials are squeezed under high pressure in a single step. When used for the extraction of food oils, typical raw materials are nuts, seeds and algae, which are supplied to the press in a continuous feed.

- **Coconut oil:** This is edible oil derived from the wick, meat, and milk of the coconut palm fruit. Coconut oil is a white solid fat; in warmer climates during the summer months it is clear thin liquid oil, melting at warmer room temperatures of around 25 °C. Unrefined varieties have a distinct coconut aroma.
- **Reduction gearbox:** A reduction gearbox, or speed reducer, is used to decrease the velocity of the input from the motor while also improving the torque the input produces.
- **Electric Motor:** An electric motor is an electrical machine that converts electrical energy into mechanical energy. Most electric motors operate through the interaction between the motor's magnetic field and electric current in a wire winding to generate force in the form of torque applied on the motor's shaft.
- **Frame:** Frames are rigid, stationary structures designed to support loads and must include at least one multi-force member.

CHAPTER TWO

LITERATURE REVIEW

2.1 HISTORY OF COCONUT AND COCONUT OIL

Coconut is cultivated all over the world in the humid tropics, mostly close to the seashore. The world leading producers of coconut are Philippines, Indonesia, India, Malaysia and Thailand. In tropical Africa, the crop is mostly produced in Mozambique, Cote d'Ivore, Tanzania and Nigeria (de Neve de Roden et al., 2001). The matured coconut plant produces fruits after pollination. The fruit is a drupe consisting of seed (coconut) covered by thick fibrous envelope or husk. The husk (mesocarp) is covered by thin leathery epidermis (exocarp). The coconut has hard thick shell (endocarp), which contains thick layer of firm, white, oily endosperm or albumen, called copra and a central cavity partly filled with sugary coconut water (Salunke and Desai, 1986). World production of copra (dried coconut meat) has been estimated at 3.3 million per year. This corresponds to 2.3 million tons of coconut oil (Essiamah, 1985). Green copra consists of 40% oil, 43% water and 17% non-oil products (Neve Roden, 2001). Studies have shown that oil contents of white meat coconut can be increased from 40% to 71% when dried to copra (Khan and Hanna, 1983; Adekola, 1992). The oil contains about 91% saturated fatty acids (44.1-51.3% lauric acid, and 5.4-9.5% coprylic acid, 4.5-9.7% capric acid 13.1-18.5% muriatic acid, 7.5-10.5% politic acid and 1.0-3.7% stearic acid). The unsaturated fatty acid (9%)

constitute about 5.0-8.2% oleic acid and 1.0- 2.6% linoleic acid, while the copra cake contains 20% protein (de Neve de Roden *et al.*, 2001). The oil is used in margarine, baking, biscuit production and cooking. In addition, it is also used for making soap, detergent and candle. The by-product of the copra, the coconut cake, is sold as a valuable animal feed (TPI,1971; Adekola, 1992).

Virgin coconut oil (VCO) is the purest form of coconut oil. Introduced onto the world market at the end of the 20th century, it is one of the highest value products derived from the fresh coconut. From a much maligned substance in the 1970s and 1980s — the American Soybean Association claimed that coconut oil caused heart disease and atherosclerosis — this high quality version has resurrected the reputation of coconut oil and made a dramatic turn-around in the world market as a functional food that not only nourishes but also heals. Because of its multi-functional uses and the way it can be produced at different production levels, VCO has been generating a lot of interest in coconut-producing countries as well as importing countries. VCO production offers an opportunity to coconut farmers to improve their income with this alternative to low value copra production. In February 2006, the Food and Agriculture Organization Regional Office for Asia and the Pacific (FAORAP) published the manual *Virgin coconut oil production manual for micro and village scale processing*. This is a ready reference that discusses key aspects of the production of good quality VCO. One of the major concerns with producing VCO on a home, micro and village scale of operation is achieving a product with consistently good quality that will meet international standards and always be fit for human consumption.

Philippines, Indonesia, India, Sri Lanka, Mexico, West Malaysia, and Papua & NewGuinea are the 7 countries which produce major quantities of coconut in the world. Coconut is available in two forms viz., wet and dry materials commonly known as wet coconut and dry coconut or copra. The oil can be extracted from both these raw materials. However, in India and Sri Lanka, it is a general practice to use only copra for oil extraction and the oil is used for food and cosmetic purposes. In Philippines, the oil is extracted from wet coconut also and is known as virgin coconut oil. In some countries solvent extraction of the dry coconut followed by refining, bleaching and deodorization is carried out to get the refined bleached and deodorized coconut oil. The technology for the production of coconut oil through expellers is well developed and many medium scale industries in India produce oil by this method. However, some small-scale industries produce the oil by processing fresh coconut also using local expeller press. Problems of sediments and rancidity persist in these oils (Cornelius, 1973). In the Cook Islands in the South Pacific, particularly Rarotonga Island, slices of fresh, mature coconut kernel are served with fruits every after meal. In India, the use of coconut for food and its applications in the Ayurvedic medicine were documented in Sanskrit 4000 years ago (Kabara, 2000).

Records show that in the United States, coconut oil was one of the major sources of dietary fats, aside from dairy and animal fats, prior to the advent of the

American edible oil(soybean and corn) industry in the mid-1940s (Dayrit, 2005). Dayrit has reviewed the long history of usage and the diverse studies done to characterize and define the composition of the12 various components of the coconut tree, its fruit and the related products derived from it, established the coconut's uniqueness and superiority among agricultural crops and every part of the coconut tree and its fruit can be either consumed by humans or animals or converted into other valuable products. If properly utilized, the coconut has the highest economic value among the palm family. This is why the coconut is normally referred to as the Tree of Life, Man's Most Useful Tree, King of the Tropical Flora, Tree of Abundance.

2.2 PROPERTIES AND USES OF COCONUT OIL

2.2.1 PROPERTIES OF COCONUT OIL

1. It has high saturated fat content
2. It is slow to oxidize and, thus, resistant to acidification lasting up to six months at 24°c without spoiling.
3. It does not exhibit gradual softening with increasing temperature unlike other fats.
4. It is a liquid about 27°c or higher and solidifies at 22°c.
5. It contains the highest percentage of medium chain fatty acid.

2.2.2 USES OF COCONUT OIL

A. FOR COOKING AND RECIPES

- A great cooking oil with high smoke point and good for baking, stir-frees or as a dairy free replacement to butter.
- Added to foods or smoothies daily for energy.
- Its lauric acid and medium chain fatty acid content helps to boost metabolism when used in foods.
- It is used as replacement for vegetable oils in any recipe or in cooking.
- It is used to make coconut cream concentrate for a brain boosting snack.

B. FOR HAIR TREATMENT

- It can be rubbed into the scalp daily to stimulate hair growth.
- It is used to make homemade shampoo bars.
- It can be used to make a great anti-frizz treatment.

C. FOR BETTER HEALTHY STATE

- It has been known to increase absorption of calcium and magnesium.
- It is used internally as part of the protocol to help rematerialize teeth.
- It is an immediate source of energy.
- It can help to speed weight loss when consumed daily.
- It helps to boost hormone production.
- It helps to improve sleep when taken daily.
- It helps the skin to heal faster after injury or infection because of its fats.

D. FOR BODY BEAUTIFICATION

- It is used on the skin as a basic lotion.
- It helps to increase sun tolerance and avoid burning when used internally.
- It is mixed with salt to remove dry skin on feet.
- It serves as a natural deodorant.
- It is used on cuticles to help nails grom.
- It is a complete natural baby lotion.
- It is used to make natural shave cream and after shave lotion.
- It is used as massage oil.
- It serves as an excellent eye-makeup remover on its own.

E. FOR NATURAL REMEDIES

- It is used to improve oral health.
- It is used inside of the nose to help alleviate allergy symptoms.
- It can help to cure eczema or psoriasis.
- It helps to improve cholesterol ratios.
- It can reduce the itch of mosquito bites.

2.3 PROCESSING METHODS FOR COCONUT OIL PRODUCTION

Virgin coconut oil can be produced directly from the fresh comminuted (grated, chopped, granulated) coconut meat, or from coconut milk, or from coconut milk residue. The choice of the technology to be adopted depends to a great extent on the scale of operation, the degree of mechanization desired, the amount of investment available and the demands of the prospective buyer. The following equipment / methods are used in extracting coconut oil;

1. Traditional method
2. Manual press
3. Ghani
4. Expeller

Before the coconut oil can be obtained with use of the press, the following processes have to be performed;

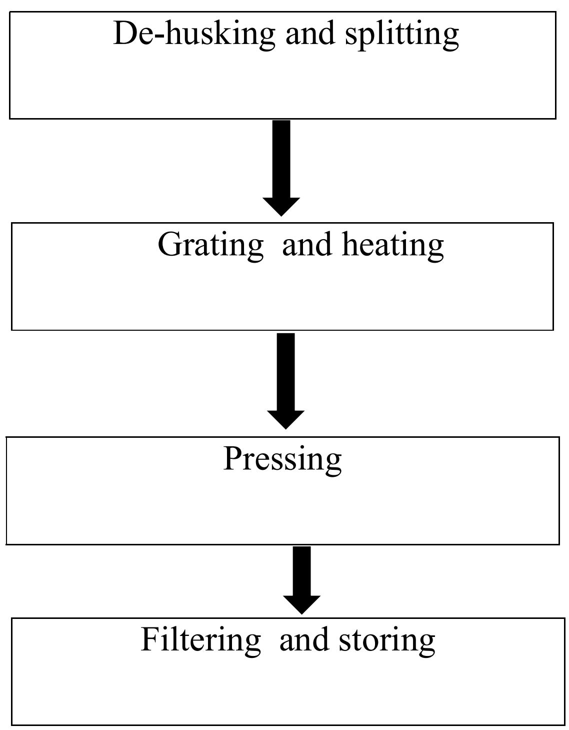

Fig. 2.1: Process of obtaining Coconut oil

1. TRADITIONAL METHOD

This involves the use of wood to heat up the coconut meat. It is hazardous to health due to the production of smoke and it requires more time to produce the oil which makes it less portable.

2. MANUAL PRESSER

This extraction machine consists of a compression chamber, vertical presser and frame, table stand for production mechanism. The manual pressure is applied on the coconut meat. The assembly can be mounted on table stand. The chamber containing the coconut meat attached to the tray and frame. While the thread is rotated by manually, the piston moves vertically downwards inside the box with a high pressure on the coconut meat, the extracted virgin coconut oil comes out through the container holes

3. GHANI

The ghani consists of a 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. Coconut meats 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 the mortar and the cake is scooped out by hand. This method is slow and requires two animals, replacing the tired one with another after about 3-4 hours of work.

Motorized ghanis are faster than manual or animal types but are more expensive and their higher capital and operating costs will require a larger 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 pressures 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 also be used for copra, groundnuts and sesame.

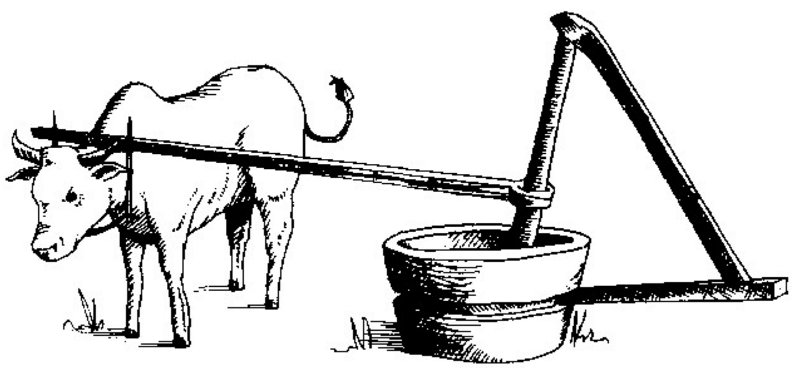

Fig. 2.2: Ghani Process Extracting Coconut Oil (Source: fao.org)

4. EXPELLERS

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. Heated oilseeds enter one end of the barrel through the feed inlet and are conveyed by the rotating 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.

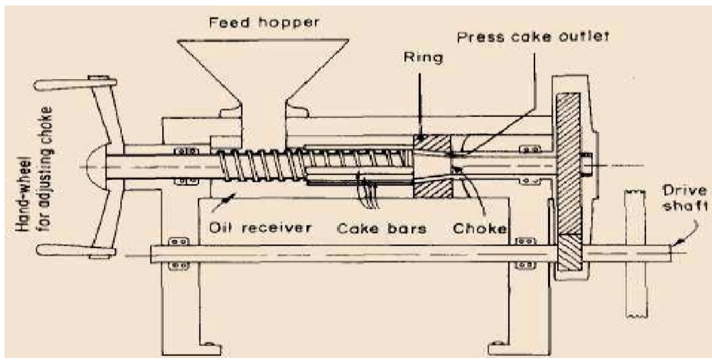

Fig. 2.3: Working Principle of an oil expeller (Source: N. Pramodkumar, 2017**)**

CHAPTER THREE

METHODOLOGY

3.1 RESEARCH DESIGN

The materials used for the fabrication of the coconut oil expeller were mainly mild steel and stainless steel. The design was targeted towards low cost construction, high digestion efficiency and means of mobility. The various parts of the machine were produced using fabrication, assembly and machining processes

3.1.1 DESCRIPTION OF THE MACHINE

This entails all sets of methods used in the design and construction of coconut oil expeller, so that the available resources are transformed into the best way possible. This include all methods used for design consideration, the design calculation, the design specification, the choice of material, the manufacturing processes and the safety put in place to bring this project to existence. The fabricated coconut oil expeller consists of seven major components which are listed below;

- The frame
- Compression chamber
- Hopper
- Cone
- Electric motor
- Gear

3.2 DESIGN SPECIFICATION AND CONSIDERATION

Standard values were used in developing the design, drawing and specification, in order to satisfy operational requirements and design purposes. The design fabricated and standard parts include shaft, hopper, base frame, pulley, bearing ICE, gear differential unit.

The design considerations in the development of the machines are as follows or the deign consideration concerned with the development these machines are:

1. Load capacity
2. Properties of material used for construction.
3. Reliability of the system
4. Maintenance strategy
5. The environment

3.3 CHOICE OF MATERIAL

For intelligent and resourceful design, there is a vital concern on the materials available for use hence; an initial knowledge of the properties and behavioral characteristics of materials chosen for this project involves a compromise. Therefore, the requirement taken into consideration for the choice of materials used for this project can be broadly classified into:

a. Service requirement

b. Fabrication and workability requirement

c. Economic or cost requirement

3.3.1 SERVICE REQUIREMENT

To ensure that the components are successful in service, they were selected based on their suitability for strength, hardness, toughness, rigidity density and thermal conductivity.

3.3.2FABRICATION REQUIREMENT

The behavior of the materials during processing such as formability machinability, welding electrical stability and chemical durability were considered in other to satisfy the need of the project. Material were also selected to suit various parts of the machine (coconut oil expeller), mild steel was there for the major material used for the fabrication work.

3.3.3ECONOMIC OR COST REQUIREMENT

We ensure that the material available can be locally sourced in other to save cost and for future development of the machine. Below are the major parts and the reasons for the material selection.

(a) SHAFT: The shaft made of steel receives the motion transmitted by the gear box. The steel shaft therefore has a suitable tensile strength; it is machine able and can also withstand torsional stress.

(b) HOPPER: This is the unit into which the material is introduced for expelling it is made of mild steel of 1.5mm thick so that the tension strength can withstand vibration.

(c) OIL COLLECTOR: The oil collector is designed in such a way that it can easily be detached and to avoid the contamination of the oil coming out from the cage bar through corroded collector. The collector then made from steel of suitable strength.

(d) SUPPORT: The support was made from angle bar steel of 50 x 50 x 8 (mm) because of its tensile strength and can also withstand deformation when the load on it is more than necessary.

(e) CAGE BAR: Twisted steel rod was used for the construction of cage bar because it can withstand internal pressure.

(f) BEARING: Bronze bearing were chosen for the design due to its wear resistance despite the softness of the metal, its low coefficient of friction and it can withstand the temperature encountered during its usage under heavy load conditions. It is also corrosion resistance and have a similar coefficient of expansion to that the housing which contains it.

3.4DESIGN CALCULATION

3.4.1 DESIGN ANALYSIS OF THE WORM SHAFT

In order to completely analyses the design of the worm shaft, it is important to consider the rupture or crushing strength of the coconut under a compression load in the screw shaft, the coconut are subjected to movement and also to similar compressive load against a rigid stationary body. The American Society of Agricultural Engineering (ASAE) described a compression test using a spherical hand

tool. This test gives the crushing strength of the coconut under a compressive load. From the experiment carried out, the value of the crushing strength of the coconut was given a 1.042N/mm". The design for the shaft is such that it can exert this value of crushing strength the coconut. The formula for calculating the area or contact between a spherical tool and. the convert body of the coconut is;

$$A = HdD/2(H + d) \tag{3.1}$$

The compressive stress exerted on the coconut at the crushing point is;

$$t = \frac{force\ (F)}{Contact\ Area\ (A)} \tag{3.2}$$

Substituting for 'A' in equation 3.2, we have;

$$t = \frac{2(H+d)F}{HdD} \quad (N/mm^2) \tag{3.3}$$

The force, F which is the load on the shaft screw is given by;

$$F = \frac{HdDr}{2(H+d)} \quad (N) \tag{3.4}$$

Where;

A = Area of contact between the surface of the tool (screw shaft and kernel) (mm^2)

H = Average diameter of the coconut material at the point of compression (mm)

D = Approximate deformation of coconut material (mm)

d = Radius of crushing shaft (mm)

f = Crushing load at crushing point (N)

R = Average radius of sample (mm).

t = Stress at crushing point experiment as state; 1.042N/mm" thus, force in load builds up a torsional moment at the shaft.

3.4.2 TORSIONAL LOAD ON WORM SHAFT

The general of the total torsional load exerted on the shaft result from the load and force built up along the line. The torsional load can be determined as giver below, where is the force that would produce a crushing stress of 1.04N/mm² on the copra.

Fig 3.1. Worm Shaft with a Cone

Torsional load = f x L (3.5)

L= moment due to the worm

The total torsional load on the shaft is derived by multiplying the torque developed by the screw, the numbers of screw threads on the shaft. That is;

T shaft = n x f x L (3.6)

Where,

n = number of screw threads.

3.4.2 DETERMINATION OF MOTOR CAPACITY REQUIRED TO OVERCOME THE TORSIONAL LOAD

Consider the expression below for electric power.

Power (kw) = Torsional load x shaft speed × 25r /1,000 x 60 (3.7)

3.4.3 DETERMINATION OF THE DIAMETER OF WORMSHAFT

From the experiment carried out that is from the table of c rushing strength of palm kernel acting on the shaft due to its action. Load f, acting on the shaft due to action of palm kernel = 2.5kg × 981 = 24.525N

This load will cause bending moment on the shaft load on shaft fi = 24.525N

Length of the shaft = L3 = 914.4mm = 0.9144,

Thus,

Bending moment, M, acting on the shaft = 2s x Fc (3.8)

For bending loads, the bending stress, is for the shaft without key-way is 38.5MN/m) and τK = 2.0 x (38.5 x 10^6N/m^2) for a solid shaft

$d^3 = 16\{(\tau K \times Ms)^2 + (Kt \times Mt)^2\}^\wedge½$ (3.9)

Having little or no torsional moment on the shaft, the equation above reduces to;

$d^3 = \frac{16}{\pi\tau S}((\tau_k \times Ms)^2\}^\wedge½$ (3.10)

From equation 3.8 above

Bending moment acting on the shaft = $L_s \times F_l$ = 0.9144 × 24.525 = 22.426Nm

From solid shaft equation 4.0

$d^3 = \frac{16}{\pi\tau S}((\tau_k \times Ms)^2\}^\wedge½$.

$d^3 = \frac{16}{3.142 \times 38.5 \times 10^6}[(2 \times 22.425)^2]^\wedge½$

$d^3 = \frac{16 \times [(44.852)^2]^\wedge½}{1.21 \times 10^7}$

$d^3 = \frac{16\times(44.852)^\wedge½}{1.21\times10^7}$

$d^3 = \frac{16\times(44.852)}{1.21\times10^7}$

$d^3 = \frac{717.632}{1.21\times10^7}$

$d^3 = 5.93\times 10^{-5}$

$d = 3\sqrt[3]{5.93 \times 10^{-5}}$

d= 0.038995m

d= 38.995mm

d= 39mm

3.4.4 DETERMINATION OF ELECTRIC MOTOR REQUIRED TO DRIVE SHAFT

The horse power required to overcome the torsional load, T is given by the expression below, considering shaft speed of 283.78rpm (max. speed)

Power= Torque (maximum) x Angular Velocity

Power = T x W

$=T \text{ X } 2\pi\frac{N}{60}$

Power = $\frac{213992.8224}{60}$ = 3566.55 watt

1hp = 746watt

$\frac{3566.55}{746}$ = 4.78hp

=5hp

Therefore, 5-horse power of 283.78rpm is required to drive the shaft.

3.4.5 DESIGN OFGEAR IN THE AXLE CASING FOR SPEED REDUCTION

There are numerous approaches to gear design. No firm rules can be established since there are so many variables. However, most manufactures follow the procedure by bucking ham Gleason or those recommended by the American Gear Manufacturers Association, AGMA. Although any procedure used for gear design should be considered as preliminary until by experiment to specify requirement.

3.4.6 STRENGTH DESIGN

The permissible force, f, which may be transmitted, is;

F = sty (L.b)m/(L) (3.11)

Where

S= allowable bending stress (N/m²)

y - form factor base on the formative number of teeth and the type of tooth profile.

I = the cone distance, m, and is equal to the square root of the sum of the square of the pitch radii of the mating gears (for shaft intersecting at 90º)

b = the face with of the gear (m)

m= the module based on the longest tooth cross section for easy manufacture and satisfactory operation of the bevel gear, it is recommended that the face width be limited to between L/3 and L/4, where L is the cone distance.

When designing for strength, the diameter of the gear may be other know or unknown. When the diameter is known, it is convenient to use the modified Lewis equation in this form.

1/My = sbr(L. b)/F(L) (3.12)

When the diameter of the gear is unknown, it is convenient to used this form of Lewis equation,

5 - 2Mt(L) /M^2bryN(L-b) actual stress allowable (3.13)

This equation will yield a value for the actual stress in term of M^3 that is making the following substitution

b = h/3 = MNP/6 (1 + R^2) 1/2

L/L -b = 3/2 (3.14)

N = actual number of teeth on the weaker gear.

3.4.7 THE DYNAMIC LOAD (FD)

The dynamic load, fd is the load transmitted plus an incremental lead due to dynamic effect and it may be approximated from

$$t = \frac{f+21v(bc+f)}{21v+(bc+f)^{\wedge}½} \qquad (3.15)$$

Where

f= the transmitted force which is determined by dividing the torque onthe weaker gear by the pitch radius

V = pitch line velocity (m/S)

b = face width of gear (m)

C= constant in N/m which depend on the tooth form material.

However, fd must be ≤ to where fo and fw are allowable values of limiting endurance's load respectively which must not exceed the dynamic load.

3.4.7.1 THE WEAR POWER RATING

The wear power rating recommended by the American Gear Manufactures Association (AGMA) standard expressed in 15 units is

Power (kw) = 0.8cm Cbb(for spiral bevel gear) (3.16)

Where

Cm = Material factor

$$Cb = \frac{Ap^{1\cdot 5}n}{0.032}\frac{(5.6)}{(5.6+(v))\hat{}\frac{1}{2}}$$

3.4.8.0 SHAFT (WORM SHAFT DESIGN)

3.4.8.1 DESIGN ANALYSIS FOR SOLID SHAFT

The shaft in this design is subjected to both torsion and bending moment, hence, the shaft would be designed on the basis of strength and rigidity in order for the shaft to be able to resist or accommodate both moment simultaneously.

Applying maximum shear stress theory, which is usually based on ductile materials such as mild steel. Therefore,

Maximum shear stress, $\tau = \frac{1}{2}(\tau w^2 + 4\tau S^2)^{\frac{1}{2}}$ (3.17)

Where

τ_n = allowable working stress = $32m_s/\tau d^3$ (3.18)

3.5 POWER TRANSMISSION

The power generated by the 2hp electric motor is transmitted to the gear box through a set of double acting pulley in which one is fastened to the shaft of the motor while the other is on the input shaft of the gear box, the power is transmitted from one pulley to the other through belts, the output shaft is connected to the machine through a flange set up. The gear box is used basically to reduce the speed of the electric motor and increase the torque of the shaft to the requirement of the machine. The power transmission arrangement is shown in the diagram below.

Fig. 3.2; Power Transmission of Coconut Oil Expeller

3.6 ERGONOMICS

The dictionary meaning of ergonomics is the study of the environment, condition and the efficiency of a machine in particular. As concerns this project, the following points will be looked into carefully, which are the environment of the coconut oil expeller, condition of the expeller and the efficiency of the machine.

3.6.1 ENVIRONMENT OF THE COCONUT OIL EXPELLER

The coconut oil expeller should be installed in a place where draught and sunlight should not get to it so as to prevent corrosion of the metallic parts of the machine. Ample space should be provided for free movement of the operators during use. Good surroundings that is good housekeeping will ensure that the oil expeller is free from contamination.

3.6.2 CONDITION OF THE COCONUT OIL EXPELLER

The working condition of the coconut oil expeller should be maintained to achieve the right efficiency, some of which are

a) The shaft and bearing must be properly aligned

b) The appropriate motor capacity should be used

3.7 SAFETY PRECAUTION DURING USE

The general safety rules in Engineering should be observed alongside this once listed below.

(a) All rotating parts most be properly guarded.

(b) The coconut must be fed in gradually until the cage is ¾ filled.

(c) The coconut must be carefully selected so as to avoid stones and solid particles in it as this will result in excessive but up pressure.

(d) The motor must be started first for the system to attain maximum speed before feeding in the copra.

3.8 MANUFACTURING PROCESSES

These are processes used for the production of the coconut oil expeller and they are as follows;

3.8.1 MEASUREMENT: The manufacturing process of this design began with but the various parts to the required dimensions and marking out.

3.8.2 CUTTING PROCESS:

Oxy-acetylene flame was used in the cutting of the metal plate and the power saw was used on the 20 inches twisted rod. Also, the power saw was used in cutting the shaft and the u-channel used for support to the required size

3.8.3 MACHINING PROCESS:

The lathe machine was used to provide a good surface finish for some of the machine component parts like the shaft. Also, drilling operations are carried out on the drilling machine to provide holes for the bolts and nuts to hold the bearing housing against the frame and also to hold split cylinder together for easy access, for maintenance purpose.

3.8.4 JOINING PROCESS:

This is the process by which the various component parts of the machine were put together. The bolts and nuts were used in areas where temporary joints were needed while in areas that needed permanent joints like the frame support, electric arc welding machine was used.

3.8.5 OTHER PROCESSES:

Processes such as annealing, hardening were also carried out on some machine component as required. The shaft was annealed to allow machining because of its original hardness.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 PERFORMANCE EVALUATION

Coconuts were gotten from Uchi market in Auchi. The coconuts were dehusked and splitted. The test was carried out for both wet and copra coconut.

4.2 PRESENTATION OF RESULTS

Tests were conducted to find out the optimum moisture content, feed rate and efficiency of expeller. The test results are given below.

4.2.1 SIZE AND SHAPE OF COPRA

Size and shape of copra sample is an important variable which affects the amount of oil obtained and easiness of the operation. Larger sized samples get blocked in the clearance between the screw shaft and barrel, whereas small sized samples get discharged without proper compression.

4.2.2 OIL OUTPUT

Oil output is an important factor which affects the overall efficiency of the oil expeller.

$$\text{Oil Output (\%)} = \left(\frac{\text{Weight of Oil}}{\text{Weight of Copra}}\right) X\ 100 \qquad (4.1)$$

4.2.3 CAKE OUTPUT

Cake Output (%) = $\left(\frac{\text{Weight of Cake}}{\text{Weight of Copra}}\right) X\ 100$ (4.2)

For the determination of oil recovery with respect to moisture content, a test was conducted. During the test seven 2 kg samples, each having different moisture content was used. During the first pass, 2 kg samples were fed to the expeller. During the second pass, cake obtained from the first pass was fed to the expeller. During the third pass, cake obtained from the second pass was fed to the expeller. Total oil recovery from one sample will be the sum of the oil recovery from all the three passes. Each sample was fed separately to the expeller. The test results are shown in the table given below along with the percentage loss of each sample.

Table 4.1: Determination of Oil Recovery With Respect To Moisture Content

Moisture content of copra (% wb)	Batch	Weight (kg)			Loss (%)
		Sample used	Oil	Cake	
5.6	I	2.000	0.654	1.214	6.60
	II	1.214	_	1.191	1.89
	III	1.191	_	1.180	0.92
6.5	I	2.000	0.680	1.253	3.35
	II	1.253	_	1.150	8.22
	III	1.150	_	1.060	7.82
6.8	I	2.000	0.613	1.285	5.10
	II	1.285	0.296	0.888	7.86
	III	0.888	_	0.821	7.54
7.2	I	2.000	0.582	1.334	4.20

	II	1.334	0.308	0.926	7.49
	III	0.926	0.175	0.687	6.90
8.2	I	2.000	0.464	1.432	5.20
	II	1.432	0.279	1.056	6.77
	III	1.056	0.123	0.888	4.26
9.1	I	2.000	0.412	1.502	4.30
	II	1.502	0.191	1.275	2.39
	III	1.275	0.056	1.106	8.86
10.4	I	2.000	0.406	1.501	4.65
	II	1.501	0.103	1.275	8.19
	III	1.275	0.027	1.156	7.21

During the test, copra samples with moisture content 5.6 %, 6.5 % and 6.8 didn't yield oil recovery from all the three passes. Remaining samples yield oil during the 3 passes. For sample with moisture content 7.2 % yielded 1.065 kg of oil from 2 kg of copra. Which was the highest oil recovery obtained during the test. Considering the working conditions and optimized feed rate, 7.2 % m.c was the most appropriate moisture content for maximum oil recovery.

4.3EFFICIENCY

Complete extraction of oil from copra is not possible by mechanical methods. Solvent extraction methods are most efficient way to determine maximum oil content present in a (Lou et al., 2009). Hence, solvent extraction is needed to determine the maximum oil content present in the copra. Soxhlet apparatus was used to determine the oil content, in which hexane was used as the solvent. Oil obtain during the chemical extraction method was 62.8% in weight basis, which is considered as the maximum oil recovery from copra and efficiency of oil expeller is calculated based on this data.

$$\text{Efficiency (\%)} = \left(\frac{\text{Oil Output}}{62.8}\right) X\ 100 \qquad (4.3)$$

The efficiency of the power operated coconut oil expeller was found out by estimated oil recovery from copra. The bar diagram shown below represents the efficiency of oil expeller corresponding to each moisture content. A maximum oil recovery of 84.8 % was obtained for the sample of 7.2 % (wb) moisture content.

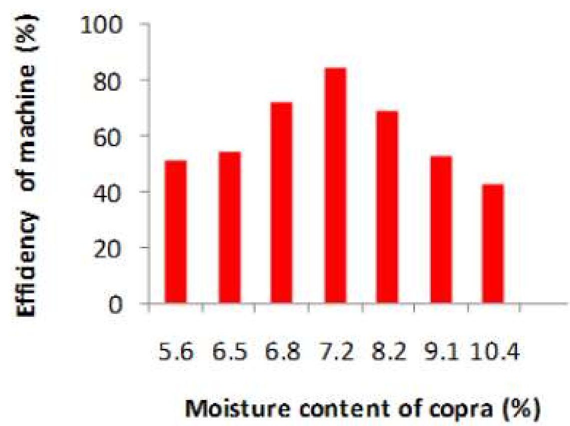

Fig. 4.1; Efficiency of coconut oil expeller with respect to different moisture content

4.4 BILL OF ENGINEERING MEASUREMENT AND EVALUATION

This section aimed at analyzing the financial involvement for the construction of this project work

Table 4.2: MATERIAL COST

S/N	MATERIAL DESCRIPTION	QUANTITY	UNIT COST	TOTAL
1.	50mm angle bar	4	9,000	36,000
2.	12mm twist rod	3	1,800	5400
3.	75mm shaft (4ft long)	1	30,000	30,000
4.	120mm pipe	1	5,000	5,000
5.	G'10 electrode	1	3,000	3,000
6.	Pillow block bearing	2	1,600	3,800
7.	Cutting disc	1	1,000	1,000
8.	1.5mm mild steel sheet	1	18,500	18,500
9.	2 inch angle bar	1	3,000	3,000
10.	2 by 2 flat bar	1	5,100	5100
11.	6mmplate (2ft by 2ft)	1	3,500	3,500
12.	Electric motor (2Hp)	1	50,000	50,000
13.	Grinding disc	1	500	500
14.	24mm bolt and nut	4	500	2,000
15.	Washer	26	25	650
16.	22mm bolt and nut	18	60	1,080
17.	Universal coupling	1	6,000	6,000
18.	Paints	1	1,500	1,500
19.	Workmanship		12,000	12,000
20.	Transportation		1,500	1,500
21.	Miscellaneous		1,500	1,500
	TOTAL			191,030

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The following conclusions can be drawn based on the test carried out on the machine.

1. Properly grated coconut will be extracted easily.
2. High quantity and quality oil can be extracted with the use of this extractor.
3. It reduces stress undergone during the traditional method
4. The machine can help in small scale coconut oil production.

5.2 RECOMMENDATION

In order to make coconut oil extraction easy and more efficient, the following recommendations should be considered.

• The use of electric motor in coconut oil extraction.

• The fabrication of grating machine together with the motor driven machine.

• Provide a mesh at the oil outlet to avoid the presence of sediments in the oil.

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