'RODUCTION OF EDIBLE OIL FROM PALM KERNEL

BY

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(MATRIC NO: 2004/18470EH)

THE DEPARTMENT OF CHEMICAL ENGINEERING,

FEDERAL UNIVERSITY OF TECHCOLOGY MINNA,

NIGER STATE, NIGERIA.

DECEMBER, 2009.

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A PROJECT TO BE SUBMITTED TO

THE DEPARTMENT OF CHEMICAL ENGINEERING,

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IN

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DECEMBER, 2009.

DEDICATION

I AJIBADE SAHEED.O of matric number 2004/18470EH dedicate this research project work to the Almighty Allah, the beneficent and the most merciful and also to my grandmother Mrs. Ajibade Alimat Sadiat for her caring and encouragement given to me during my course of study.

CERTIFICATION

research project by AJIBADE SAHEED .O of Matric Number 2004/18470EH has examined and certified under Engr. A. G. Isah to be adequate in scope and quality for ilfillment of the requirement for the award of bachelor of Engineering (B. ENG) in ical engineering.

.... 20/11/09...........

:. A. G. Isah — Signature and date

ervisor

....

gr . J. O. Okafor — Signature and date

Head of Department

....

ternal Examiner — Signature and date

DECLARATION

I, AJIBADE SAHEED .O hereby declare that this project presented for the award of bachelor of Engineering Degree in chemical engineering of the Federal University Of Technology Minna, Niger state has not been done for any degree elsewhere but to the best of my knowledge.

.... 01/02/2010 ....

Ajibade Saheed.O — Date

(Student)

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ABSTRACT

This work was concerned about the production of edible oil from two common species of palm kernel seed namely Local (Dura) and Agric (Tenera) respectively through the process of extracting and refining. After extracting the oils from the kernels, the crude oil from each specie were analyzed to determine the oil yield, free fatty acid and specific gravity. The percentage oil yield of the local specie was 38.36% while that of Agric specie was 44.52%. This value indicated that the Agric specie yields more oil than the local species. The oils were refined using two different neutralizing and bleaching agents namely NaOH and KOH, fuller's earth and activated charcoal / activated carbon respectively. The refined samples obtained from each specie were analyzed to determine their quality by testing for the free fatty acid, saponification and peroxide value respectively. The Agric specie were more refined than that from the local specie as the values of the constants for Agric specie were lower than the values for the local specie.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Palm kernel seed is a seed getting from palm oil fruit (Elaeis guineensis) where oil is been obtained by extraction, the seed remain after the extraction of oil palm (red oil) is known as Palm kernel seed.

This project study undergoes an extraction and refine of the two common species namely Local (Dura) and Agric (Tenera) respectively. Also an expeller is used for the extracting of oil from the palm kernel seed.

All vegetable oils destined for consumption must undergo the process of refining to improve the physical and flavor characteristics of oil. The process of removing the non glycerides fatty materials contained in oil bearing materials by washing the oils with strongly alkaline water solution is known as Refining, but the removal of fats and oils from their natural sources is the first step in the overall process (Weiss,1963).

In this study, extraction is the removal or obtained oil from palm kernel seed but the cracking and drying of the seed is the first step before extracting. During extraction of this palm kernel seed we get two products the palm kernel oil and the residue which is the palm kernel cake. This cake can be used for animal consumption like pig, corks, hen and fish.

There are quite a number of oil seeds from which oil can be extracted and refined for consumption namely groundnut, cottonseed, soyabean, seanut, mangonut, sesame seed and palm kernel seed in this project study.

The production of edible oil from palm kernel starts with the extraction of the oil from the fruit of the oil palm (Elaeis Guineesis). But this oil palm produces another oil known as palm oil normally called Red oil. Palm oil is extracted from the outer fleshy part i.e. the pericarp, while the palm kernel oil is extracted from the kernels seeds and made to undergo some refining procedures so as to remove certain pigments, odours and colours, which make it non-edible. The oil obtained from the kernels has properties, which are quite distinct from that of the oil obtained from the outer pulp (oil palm fruit)

Palm kernel oil is obtained from the kernel of palm fruit. There are great differences between palm oil and palm kernel oil in physical and chemical characteristics. Palm kernel oil is yellowish in colour and has a different fatty acid composition, while palm oil is reddish in colour. Palm oil contains mainly palmitic and oleic acids, the two most common fatty acids and about 50 percent saturated, while palm kernel oil contains mainly lauric acid and more than 80 percent saturated. Palm kernel oil closely resembles coconut oil in its fatty acid formation and characteristic, therefore is a cost effective substitute for crude coconut oil in the production of quality soap.

Palm kernel oil is used for manufacturing margarines, specialty fats for coating, ice creams etc.In the production of non-diary creamer palm kernel oil is used to replace milk fat in the non-diary creamers or coffee-whiteners.

Also, palm kernel oil is used in the manufacturing of soap, candles, cooking oil and lubricating oil for human consumption.

The oil content of the kernels seed ranges from about 46-52 percent depending on the variety of the palm kernel, season, and impurity level (Hartley, 1977).

1.2 Aim and Objectives

The aim of this project study is to produce edible oil from palm kernels seed.

This work is carried out through the following Objectives:

i. To extract oil from the two common species using local expeller.
ii. To analyze and test the free fatty acid value and other constants in the two species.
iii. To determine the percentage of oil yields from the two species.
iv. To determine the effectiveness of two different alkalis (NaOH) and (KOH) used in alkali refining/neutralization of the two species.
v. Also to determine effectiveness of two different bleaching agents on the two species.
vi. To analyze the free fatty acid content, saponification value and peroxide value in each of refined samples.

1.3 Justification of study

The importance of this study is to familiarize the society at large on the production of edible oil on a small scale due to the availability of this oil-bearing seed in our environment. This will limit the wastage of this because it is normally seen as waste product after the oil palm (red oil) has been extracted. Also from the economy point of view, this study can be used to improve the overall income in Nigeria through the fractionation of these palm kernels using this project as a pilot project for subsequent large scale production.

1.4 Scope of the study

The scope of this study is limited to the production of edible oil from two species of palm kernel using an oil expeller in the extraction and refining on a small scale using laboratory owned apparatus. Also, the analysis and testing of the constants used in determing the quality of the oil

CHAPTER TWO

2.0 Literature Review

Asiedu, 1989 outlined that the oil palm (Elaeis guineensis) from which the palm oil is extracted is a monocotyledonous plant. Within the species E.guineensis, different varieties and types can be distinguished with respect to the quality and quantity of the extractable oil. The oil palm is largely cultivated in the equatorial regions of Africa, Southeast Asia and America, of all oil-bearing plants; oil palm is the highest yielding. In the humid regions of West Africa, yield amounts to about 4-5 tonnes of oil per hectare per annum. Global production data for oil palm indicate that in 1985, slightly in excess of 6-7 millions tonnes were produced, major contributing countries being Malaysia, the Philippines and Nigeria.

Hartley, 1988 described the structure of the fruit of oil palm is a drupe consisting an outer pulpy layer, which provides the palm oil .Within this pulpy or mesocarp lies an hard shelled nut containing the palm kernel(endocarp) which gives two useful products palm kernel oil and the residue which is palm kernel cake.

2.1 Morphology of the seed.

According to purseglove, 1972 the oil palm seed is the nut, which remains after the soft oily mesocarp, has been removed from the fruit. It consist of a shell or endocarp and one, two or three kernels. In the great majority of cases however, the seed contains only one kernel. In botanical term, the kernel is the seed, but in common parlance, the world "seed'' is used for the nut comprising of shell and kernel. Nut size varies very greatly and depends both on the thickness of the shell and size of kernel. Typical African dura nuts may be 2-3cm in length and average 4g in weight. The shell has fibres passing longitudinally through it and adhering to it and they are drawn at the base. Inside the shell lies the kernel, it consist of layers of hard oily endosperm, grayish white in colour, surrounded by a dark brown testa covered with a network of fibres.

Hartley and Asiedu, 1989 described the simple classification of the oil palm fruit is based on its internal structure especially the thickness of its shell and the fruit form maybe described as belonging to one of the following group;

i. **Dura:-** The dura specie has no fibre ring, its shell is usually 2-8mm thick, though occasionally less, low to medium mesocarp content (35-55 percent but sometimes in the deci dura, up to 65 percent).The dura specie are usually known as the "local specie". They are usually termed thick shelled forms and the nuts cannot be readily cracked.

ii. **Tenera: -** This form is a hybrid of the shell less pisifera and the common thick shelled dura. It has fiber ring, the shell is usually 0.5-4mm thick, medium to high mesocarp content (60-96 percent but occasionally as low as 55 percent).They are usually known as the "Agric specie" Also, they are usually termed thin shelled forms and the nuts can be readily cracked.

iii. **Pisifera:** - These are less common. The shell is less i.e. shell-less. They are usually named **"pisifera".** Owing to the pea-like shell-less kernels found in fertile fruit.

2.2 Extraction of oil from palm kernel

South worth, 1977, the removal of fats and oils from their natural sources is basically the first step in the overall process for the production of edible oils. The purpose of carring out extraction of oil is to obtain maximum amount of good quality oil while getting maximum value from the residual meal, although the rate of extraction of the oil depends on the type of fruit, ripeness, and age of palms season etc. These factors thus determine the yield of the extracted oil.

Pandey, 1994 described the most common methods for the recovery of fats and oils from their natural sources are rendering, pressing and solvent extraction. The technique to be used will be dependent on the amount of oil contained in the oil-bearing seed. Palm kernel oils are produced industrially by either screw pressing or mild screw pressing followed by solvent extraction.However, the latter is not often used because of high solvent cost. Therefore, most of the palm kernel oils are now produced by screw pressing using an expeller.

The mechanized process of palm kernel oil extraction consists of the following stages:

- Separation of fibers from the nuts.
- Nut cracking.
- Kernel and shell extraction.
- Extraction of the oil.

2.3. Mechanical Extraction

The mechanical extraction processes are suitable for both small- and large- capacity operations. The three basic steps in these processes are (a) kernel pre-treatment, (b) screw-pressing, and (c) oil clarification.

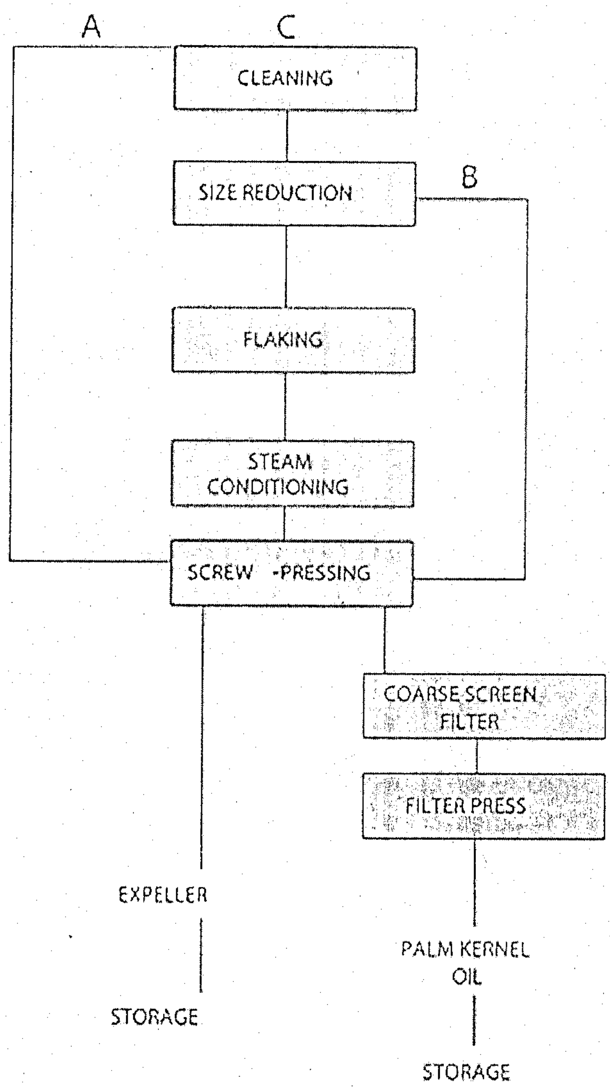

FIG 2.1 Mechanical Extraction Process

Line (A) is for direct screw-pressing without kernel pre-treatment; Line (B) is for partial kernel pre-treatment followed by screw-pressing; and Line C is for complete pre-treatment followed by screw-pressing.

2.3.1. Kernel pre-treatment

Proper kernel pre-treatment is necessary to efficiently extract the oil from the kernels. The feed kernels must first be cleaned of foreign materials that may cause damage to the screw-presses, increasing maintenance costs and down time, and contamination of products. Magnetic separators commonly are installed to remove metal debris, while vibrating screens are used to sieve sand, stones or other undesirable materials.

A swinging hammer grinder, breaker rolls or a combination of both then breaks the kernels into small fragments. This process increases the surface area of the kernels, thus facilitating flaking. The kernel fragments subsequently are subjected to flaking in a roller mill. A large roller mill can consist of up to five rollers mounted vertically above one another, each revolving at 200-300rpm. The thickness of kernel cakes is progressively reduced as it travels from the top roller to the bottom. This progressive rolling initiates rupturing of cell walls. The flakes that leave the bottom nip are from 0.25 to 0.4 mm thick.

The kernel flakes are then conveyed to a stack cooker for steam conditioning, the purpose of which is to:

- Adjust the moisture content of the meal to an optimum level.
- Rupture cell walls (initiated by rolling).
- Reduce viscosity of oil.
- Coagulate the protein in the meal to facilitate separation of the oil from protein materials.

The meal flows from the top compartment down to the fifth compartment in series. At each stage a mechanical stirrer agitates the meal. Steam trays heat the cookers, and live steam may be injected into each compartment when necessary. The important variables are temperature, retention time and moisture content. In the palm kernel, the meals are normally cooked to a moisture content of 3 percent at 104-110°C.

2.3.2. Screw-pressing

The properly cooked meal is then fed to the screw-press, which consists of an interrupted helical thread (worm) which revolves within a stationary perforated cylinder called the cage or barrel. The meal is forced through the barrel by the action of the revolving worms. The volume axially displaced by the worm diminishes from the feeding end to the discharge end, thus compressing the meal as it passes through the barrel.

The expelled oil drains through the perforation of the lining bars of the barrel, while the de-oiled cake is discharged through an annular orifice. In order to prevent extreme temperatures that could damage the oil and cake quality, the worm-shaft is always cooled with circulating water while the barrel is cooled externally by recycling some cooled oil.

2.3.3. Oil clarification

The expelled oil invariably contains a certain quantity of 'fines and foots' that need to be removed. The oil from the presses is drained to a reservoir. It is then either pumped to a decanter or revolving coarse screen to remove a large part of the solid impurities. The oil is then pumped to a filter press to remove the remaining solids and fines in order to produce clear oil prior to storage. The cakes discharged from the presses are conveyed for bagging or bulk storage.

As can be seen from Diagram 2, not all crushers use the same procedure for mechanical extraction of kernel oil. There are three variations: direct screw-pressing, partial pre-treatment, and complete pre-treatment.

2.3.3.1. Direct screw-pressing

Some mills crush the kernels directly in the presses without any pre-treatment. Double pressing usually is required to ensure efficient oil extraction. The screw-presses used normally are less than 10 tonnes per unit per day.

2.3.3.2. Partial pre-treatment

The kernels are first broken down to smaller fragments by grinding prior to screw-pressing. In some cases, cooking is also carried out.

2.3.3.3. Complete pre-treatment

The full pre-treatment processes described earlier are carried out prior to screw-pressing. Plants with larger capacities (50-500 tonnes per day) choose complete pre-treatment and the equipment is usually imported from Europe. FATECO and Faith Engineering now offer the complete line for small-scale operators.

2.4. Solvent Extraction

Solvent extraction processes can be divided into three main unit operations: kernel pre-treatment, oil extraction, and solvent recovery from the oil and meal. For the purposes of small-scale operations it is sufficient to mention the solvent extraction process is an alternative for high capacity mills. However the process is not recommended for small enterprises.

2.5. Traditional method of Palm Kernel Extraction

Palm kernel extraction is a specialized operation undertaken by a completely different set of processors. They are usually better organized as a group and are not as dispersed as palm oil processors. The kernel processors have to go around the palm oil processors during the peak season, when prices are lowest, to purchase the nuts for drying. The nut processing and oil extraction is undertaken in the dry season when the pressure to obtain raw materials has subsided.

The traditional palm oil processing starts with the shelling of the palm nuts. The shelling used to be performed using two stones to crack each nut and separating the kernel and shell simultaneously. This manual operation has been largely superseded by the use of nut-cracking stations.

The mechanical nut-crackers deliver a mixture of kernels and shells that must be separated. The kernel/shell separation is usually performed in a clay-bath, which is a concentrated viscous mixture of clay and water. The density of the clay-bath is such that the shells sink while the lighter kernels float to the top of the mixture. The floating kernels are scooped in baskets, washed with clean water and dried. Periodically, the shells are scooped out of the bath and discarded.

The traditional oil extraction method is to fry palm kernels in old oil or simply heat the dried nuts. The fried kernels are then pounded or ground to a paste in a motorized grinder. The paste is mixed with a small quantity of water and heated to release the palm kernel oil. The released oil is periodically skimmed from the top.

Today, there are stations in villages that will accept well-dried kernels for direct extraction of the oil in mechanized, motorized expellers. (see the figures below)

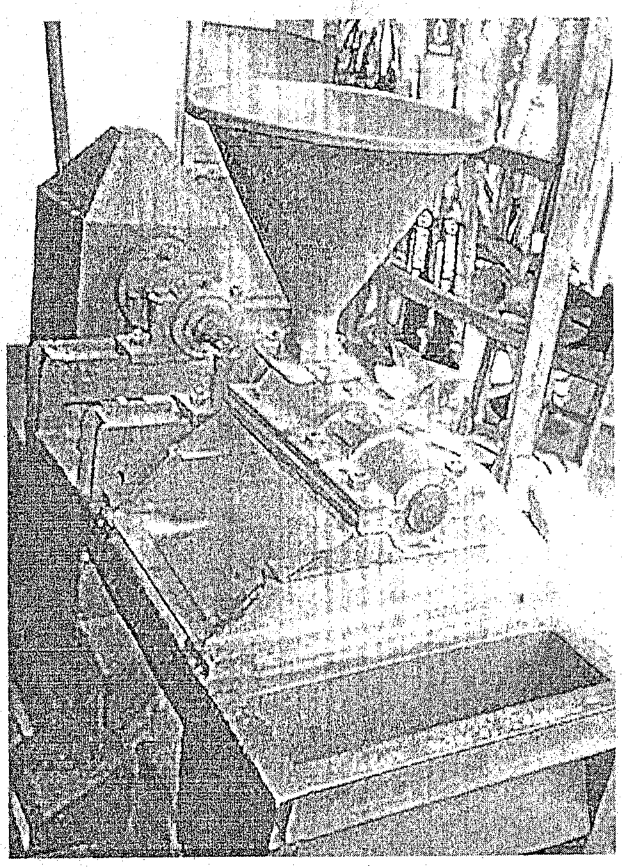

Fig 2.2 Pictorial view of whole palm kernel expeller (Benin)

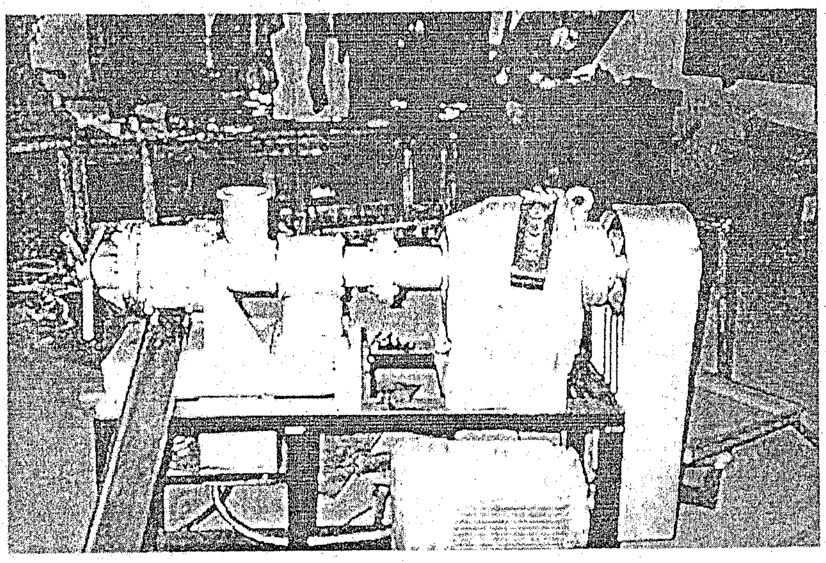

Fig 2.3 **Pictorial view of Palm kernel expeller (Cameroon)**

2.6. Physical and chemical characteristics of palm kernel oil

Hartley, 1977, described that mature palm kernels contain about 46-52 percent of oil on a moisture free basis. They vary greatly in shape, some are spherical but most of the nuts are somehow flattened and irregular and occasionally some of the nuts are pointed on one end.

Also, Hartley, 1988, that the endosperm is white and translucent when fresh. It is enclosed by a brown testa, which is fairly light in colour when the kernels are taken from unsterilized fruit. But on sterilization, the testa tends to become dark brown or almost black. The surface is always shining due to the presence of oil.

The physical characteristics of the palm kernel crude oil are:

i. It is alight yellow colored oil.

ii. It has an unpleasant, nasty and offensive odor.

The chemical characteristics of palm kernel oil as stated by Hartley, 1988 are:

i. It goes through the process of hydrolysis leading to the formation of free glycerol and free fatty acid through the splitting of the fat molecules.

ii. It goes through oxidation reaction in which unsaturated fats are oxidized at the double bond and the oxidation products, which are hydroperoxides leads to rancidity.

iii. It also goes through hydrogenation reaction or hardening.

2.6.1 Composition of palm kernel oil

Palm kernel oil is composed of the following constituents

i. **Fatty acids: -** Palm kernel oil contains the same fatty acid as coconut oil but in different proportions. Palm kernel oil contains considerable similar proportions of acids having a lower molecular weight than Lauric acid and this difference reflected in its lower reichert and polenske values. Palm kernel oils are usually called lauric acid oil due to their low unsaturation and a high content of lauric acid.

Table 2.1 Fatty Acid Composition of palm kernel oil

S/N	FATTY ACIDS	PERCENTAGE
1	<u>Saturated Acids</u>	
	Caproic	0.2
	Caprylic	2.4-4.3
	Capric	3.0-6.3
	Lauric	44.5-52.0
	Myristic	14.1-18.6
	Palmitic	6.5-10.4
	Stearic	1.3-3.5
	Arachidic	0-1.9
2	<u>Unsaturated Acids</u>	
	Hexadecanoic	0-0.6
	Oleic	10-18.5
	Linoleic	0.7-2.5

Sources: "Hartley, and Asiedu, 1989".

ii. **Glycerides: -** The glycerides composition of palm kernel oil has been investigated by Bormer and Schneider and by Dale and Meara using multiple fractional crystallization of the higher melting points fractions from acetone.

The proportion of triglycerides types in each group was calculated from the component fatty acids obtained by further gas-liquid chromatography of the butyl esters of the fatty acids in the glyceride peak with such a high proportion of saturated acids saturated triglycerides constitute over 60 percent and monooleic disaturated triglycerides more than 25percent of the total glycerides.

iii. **Unsaponifiable matter:** - Crude palm kernel oil usually contains between 0.2 and 0.8 percent Unsaponifiable matter. In past researches, a value of 0.4 percent was obtained from Indonesia for the Unsaponifiable matter.

Other constituents of palm kernel oils are moisture; protein extractable non-nitrogenous substances, cellulose, ash, dry matter and crude fibre and their values given in percentage by weight are shown in table 2.2 below

Table 2.2 Composition of palm kernel oil (percentage by weight)

S/N	CONSTITUENTS	PERCENTAGE
1	Oil	46-52
2	Crude protein	7.5-9.0
3	Moisture	6-8
4	Extractable non-nitrogenous substances	23-24
5	Cellulose	1.5
6	Ash	1.8
7	Dry matter	92.0

Source: - "Hartley, 1977"

2.6.2 Properties of palm kernel oil

Asiedu, 1989, palm kernel oils like all other vegetable oils are mixtures of a number of different glycerides.For the identification of different oils, a number of contstant have been established. These constants are used as a guide in the analysis and testing of oils and fats as well as in the assessment of their quality and purity. The constants commonly use to establish identity are melting and solidification temperature, iodine value,saponification value, refractive index,viscosity,density,reichert ,polenske and kirschner values. Other data also determine to sess the quality of palm kernel oils are the free fatty acid (FFA) contents, peroxide value oisture content and content of Unsaponifiable matter.

alm kernel oil resembles coconuts oil with which it is readily interchangeable. Both fats have reponderance of saturated fatty acid, but palm kernel oil has a lower quantity of the low olecular weight acid, caprylic andcapric as shown in table 2.3 below.

able 2.3 Properties of palm kernel oil and coconut oil.

S/N	Properties	Palm kernel oil	Coconut oil
1	Relative density	0.900-0.913	0.908-0.913
2	Refractive index	1.4495-1.4575	1.448-1.450
3	Melting range 0c	25-30	23-26
4	Saponfication value	244-254	257-254
5	Acid value	3-17	1-10
6	Iodine value	14-20	7-10
7	Reichert value	5-7	6-8
8	Polenske value	9-11	12-18
9	Unsaponifiable matter	0.2-08	0.15-0.6

Source: "Van Oss, 1975."

2.7. Refining of Palm Kernel Oil

The procedure, which are employed in the refining of palm kernel oils are degumming, alkali refining or neutralization, bleaching and filtering,hydrogenation,fractionation and deodorization.

In 1989, Asiedu j.j was able to carry out the refining of palm kernel oil. In alkali refining stage, NaOH (caustic soda) was employed in reducing the free fatty acid content of the oil.

Also in the bleaching stage, fuller's earth otherwise known as natural bleaching clay was employed as the bleaching agent. But for this project work, the refining stages carry's some additional weight. Firstly, the crude palm kernel oil will have to be degummed using the process ydration, after which the oil will be alkali refined, or neutralized using NaOH and KOH ectively. Then in the bleaching stage, two different adsorbent will be used namely bleach and activated charcoal. The already bleached oil will be deodorized accordingly.

Uses of Palm Kernel Oil

crude palm kernel oil is use in the manufacture of soap, particularly high quality toilet soap to high content of free fatty acid.

ey can also be converted to short fatty alcohols in which connection of its lauric acid content of prime importance (Asiedu, 1989).

e refined palm kernel oil is used in the formulations for margarine, shortenings and cooking s. It is particularly useful for biscuit fats, confectioneries, ice cream and biscuit filling cream ere quick melting properties and a hard brittled texture are desirable.

ey are also use in the manufacture of grease, candles, and lubricants cosmetics and chemical aning products (detergents).

industrialized countries the soap stock formed as a residue when crude palm kernel oil and ustic solution are mixed together and separated are use in soap making industries after further ocessing (Asiedu, 1989).

CHAPTER THREE

.0 Methodology

.1 The reagent used

'able 3.1 List of reagents or chemicals used.

/N	REAGENT/CHEMICAL	FORMULA	SOURCE
	Palm Kernel Nut		Local sources(palm oil fruit)
	Sodium Hydroxide	$NaOH$	Chemical Eng,Lab LAUTECH, Ogbomosho
	Potassium Hydroxide	KOH	Chemical Eng,Lab LAUTECH, Ogbomosho
	Distilled water	H_2O	Chemical Eng,Lab LAUTECH, Ogbomosho

3.2 The apparatus used

Table 3.2 **List of apparatus.**

S/N	APPARATUS	CAPACITY	SOURCE	COMMENT
1	Expeller	-		Used to Extract the Palm Kernel nut
2	Weighing Balance	-		Used for weighing the reagent
3	Stove	-		Used for heating substances
4	Stirrer	-		Used for stirring the mixture
5	Volumetric flask	$250cm^3$	Pyrex glass England	Used for measuring volume o solution
6	Conical flask	$250cm^3$	Pyrex glass England	Used for filtration
7	Separating funnel	-		Used for Separation
8	Filter paper	-		Used for filtering
9	Clamp	-		Used for supporting
10	Beaker	$250cm^3$	Pyrex glass England	Used for measuring the solution
11	Measuring cylinder	$250cm^3$	Pyrex glass England	Used for measuring the volume o solution
12	Funnel	-		Used for shaping the filter paper
13	Cork	-		Used for Covering
14	Thermometer	200^0 c		Used for measuring Temperature
15	Sand Bath	-		Used for deodorize
16	Activated Carbon	-		Used for Bleaching
17	Fullers Earth	-		Used for Bleaching
18	Flat bottom flask	$1000cm^3$	Pyrex Glass England	Used for Boiling
19	Steam generator	-		Used for deodorize

3.3 Methods used in Extracting the Oil from the Kernel

The methods employed in extracting the oil from the kernel include:

3.3.1 Cracking: - Hand cracking was employed in cracking the kernel to get nut which contains the oil. This mode of cracking was employed due to the size of kernels needed for this project. Where larger volumes of kernel are needed, a cracker can be employed.

3.3.2 **Drying:** - This nut were sun dried (after cracking) for a period of 2-3 days depending on the period of seasons;

3.3.2.1. To reduce the moisture content of the nut as this can have an adverse affect on the quantity of the oil.

3.3.2.2 To give a better yield of oil after extraction because samples that were dried thoroughly will yield more oil compared to samples that were inadequately dried.

3.3.3 Extraction: - The oil in the nut was extracted using a local expeller sited at Oyo town. This technique of extraction was chosen due to the high content of oil in the nut as established in chapter two. The expeller used for extraction was chosen because of its high efficiency between 65-70 percent. The diagrams below are the palm kernel seed and the local palm kernel expeller (crushing machine) sited at Oyo.

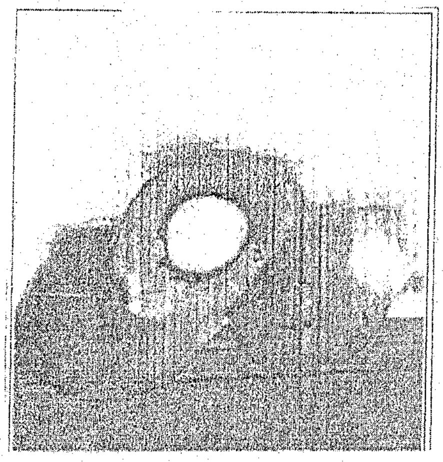

Fig 3.1 pictorial view of palm kernel seed

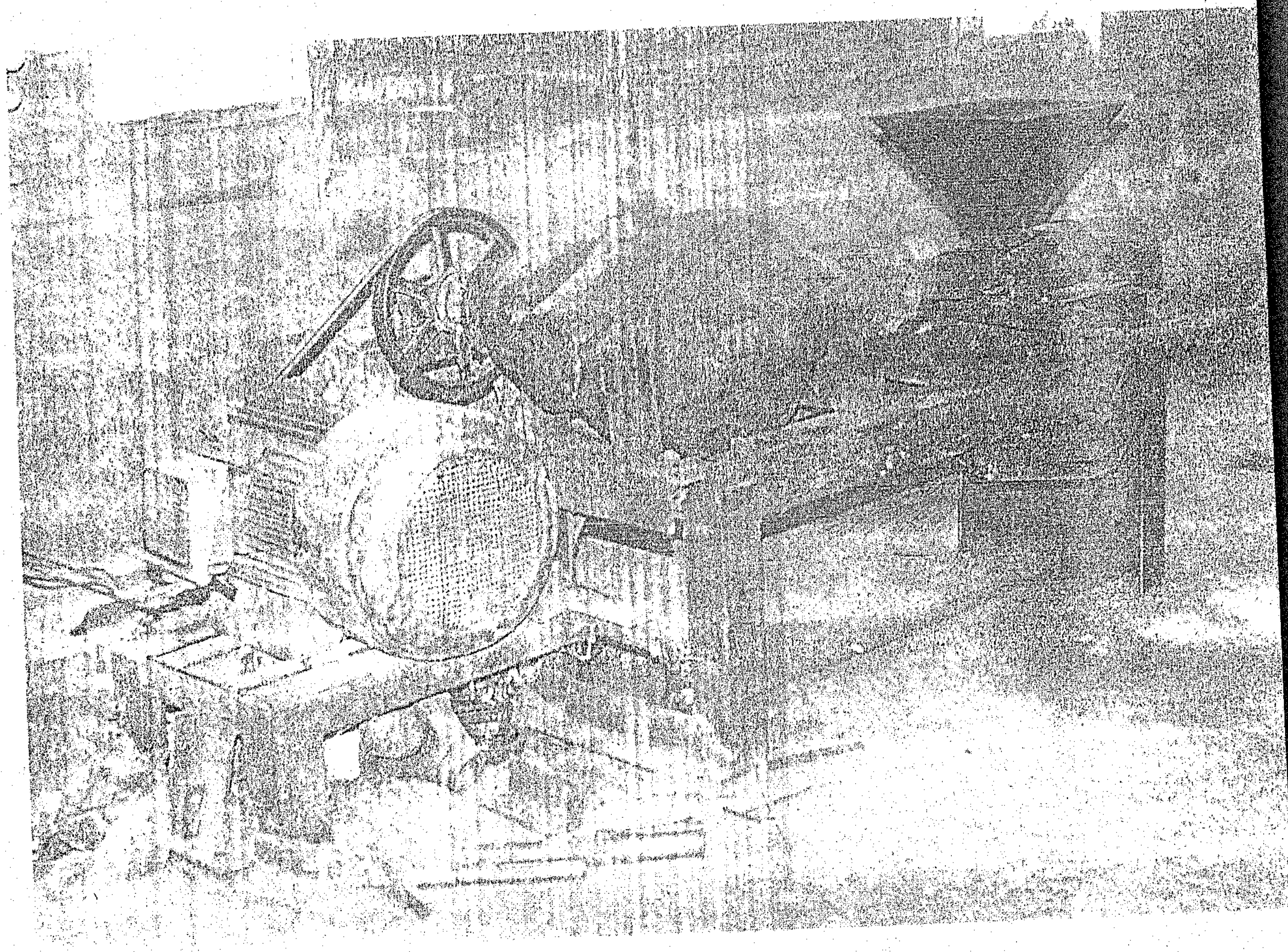

FIG 3.2 **Pictorial view of Local palm kernel Extraction (Oyo Town).**

3.3.4 **Analytical Test: -** The crude oil samples were analyzed after extraction to determine the quality of the oil. The result obtained will determine whether the final product will meet specifications were :

- Free fatty acid (FFA).
- Saponification Value.
- Specific gravity.
- Peroxide Value.

3.4. Refining of oil

The first step before the refining of the oil was carried out with the preparation of reagents needed for the refining of the oil. The reagents that were needed for refining were NaOH solution and KOH solution and both were prepared thus: NaOH was prepared by weighing 1g of NaOH pellets and dissolving in 250ml distilled water. Also, KOH solution was prepared by dissolving 1.4g of KOH pellets in 250ml distilled water and the mixture was shaken thoroughly. Both reagent were thus poured into volumetric flask and corked. After the reagent preparation, the crude samples were treated and refined using the following techniques:

3.4.1 **Degumming:-** The crude sample were degummed by measuring a known quantity of oil from the local specie already heated to a temperature of about 50Degree and added water into it. The mixture were thoroughly mixed together and allowed to stand for 30mins.After 30mins, the mixture were poured into a separating funnel to allow for quick separation and they were separated accordingly. This same operation was carried out on the Agric species but at different period of time, after which the oil was made to proceed to the next stage.

3.4.2 **Neutralization:** - The already degummed local species was thus mixed with NaOH solution .The mixture was then heated with continuous mixing/stirring and allowed to stand after heating for about 15mins.Also, a quantity of the degummed local species (another portions) was mixed with KOH using the same procedure as stated above .The mixture was then heated while the mixture was being stirred continuously and it was also allowed to stand. The mixtures were allowed to stand so that soap stock could separate out before pouring into the funnel for the final separation. After separation, hot water was added to the samples that have been neutralized and the mixtures were allowed to stand so as to separate. This procedure of adding hot water to the oil and mixing is called the oil refining washing and it is always carried out to wash out the residual alkaline solution and soap stock. The agric species was made to pass through the neutralization stage and washing stage using NaOH and KOH respectively since it was not a continuous process. This operation was carried out separately and at different periods.

3.4.3 **Bleaching:** - The already neutralized local species neutralize with NaOH was divided into two parts. The first part was bleached with activated charcoal, while the second parts were bleached with fuller's earth. For the activated charcoal bleaching, a known quantity was weighed and added to the oil with thoroughly mixed and heated. The heating continued until the temperature had risen to 100 Degree and the heating time had reached about 30mins to one (1) hour at the end of the heating the bleached oil was thus allowed to cool down before it was filtered.

Also, a known quantity of fuller's earth was weighed and added to the remaining part of the oil and heated as well. The heating continued until temperature of 100 Degree was reached and the time of heating had reached about 15-30mins.At the end of the heating, the bleached oil was allowed to cool down before it was filtered.

In the same vein, each of the bleaching agents were also used in bleaching the other part of the local breed that was neutralized with KOH solution using the same procedure of heating, cooling and filtering to removed the bleaching agent leaving behind a clear clean oil.

Also, the Agric species/breed samples were bleached in the same manner as discussed above using the two bleaching agents that was specified in this project

3.4.4 .**Deodorization:** - Each of the samples that were bleached with activated charcoal and fullers earth were then deodorized one after the other. The oil samples were deodorized by passing steam, which was generated, into the oil samples with simultaneous heating of the oil, which was placed in a sand bath. The deodorization was carried out for about 1-2hours.

3.4.5 **Analytical Test:** - Test were thus carried out on samples. These tests were carried out to determine the quality of the oil refined, although the equipment employed in carrying out the refining were not the standard equipment recommended.

Parameters that were analyzed for the refined samples were:

- Free Fatty Acid.(FFA)
- Saponification value.
- Peroxide value.

CHAPTER FOUR

4.0 Results and Discussion

4.1 How to determine the percentage of oil yield for the local and Agric Crude samples.

The percentage Oil yield analysis was carried out on the local and agric crude palm kernel oil together with their qualitative analysis results and is stated as follows:

The percentage oil yield was determined using the formula below:

$$\%yield = \frac{\text{Crude palm kernel oil produced}}{\text{Palm kernel crushed.}} \times \frac{100}{1}$$

The procedures discussed above were carried out for both the local and Agric species used for this project work.

The result of the analytical test carried out on both specie are given below in table 4.1

Table 4.1 Analytical Results obtained for the crude samples.

Species	**Values of parameters obtained**			
	PEROXIDE VALUE(milli equivalent peroxide / 100g sample)	**FFA (%)**	**SAPONIFICATION VALUE (mgKOH / g oil)**	**SPECIFIC GRAVITY**
Agric(Tenera)	0.0005	0.87	196.667	0.9328
Local(Dura)	0.0051	2.67	204.765	0.9133

4.2 Analysis of the refined oil samples.

Before the analysis was carried out, the samples were labelled thus;

Table 4.2 **Definitions of samples**

SAMPLE	SPECIE	NEUTRALIZING AGENT	BLEACHING AGENTS
A	LOCAL	NaOH Solution	Fullers Earth
B	(Dura)	NaOH Solution	Activated Charcoal
C		KOH Solution	Fullers Earth
D		KOH Solution	Activated Charcoal
E	AGRIC	NaOH Solution	Fullers Earth
F	(Tenera)	NaOH Solution	Activated Charcoal
G		KOH Solution	Fullers Earth
H		KOH Solution	Activated Charcoal

The following results were obtained for each of the refined samples after analytical test was carried out.

Table 4.2 Analytical results for the refined samples.

SAMPLE	FFA (%)	SAPONIFICATION VALUE(mgKOH/G OIL)	PEROXIDE VALUE (Meq peroxide/ 1000g samples)
A	1.72	177.743	0.021
B	1.69	175.986	0.019
C	0.86	176.715	0.025
D	0.84	175.897	0.022
E	0.19	138.089	0.0087
F	0.17	136.120	O.0081
G	0.12	143.008	0.013
H	0.11	142.004	0.010

4.3 DISCUSSION OF RESULTS.

From the results obtained for the crude samples as shown in table 4.1, It can be seen that the free fatty acids (FFA) of the Agric specie was lower than that of the local specie which implies that the Agric specie had not undergone much oxidation, as that of local specie had undergone.

Also, the percentage yield of Agric specie was higher than that of the local specie i.e for Agric specie; the percentage yield was 44.52% while for the local specie it was 38.36%. These values indicated that the Agric type have higher oil content than the local type and the yield of the crushed palm kernel oil is a determining factor that determines the amount of the end product to be recovered at the end of production.

For the refined samples the free fatty acid values obtained for the sample that were taken for local specie were high. These were due to the fact that the free fatty acid of the local specie was high, though values got for the free fatty acid of samples that were neutralized with potassium hydroxide were much lower than that got from sodium hydroxide neutralization. Also, the high value of the free fatty acid had an adverse effect on the other parameters like the saponification, peroxide values as there values were also high compared with the other samples from the other specie though they are still edible.

For samples that were taken from Agric specie, the free fatty acid (FFA) were lower than that of local specie and these can be attributed to the lower value of the crude sample from which they were taken. The values are 0.19, 0.17, 0.12 and 0.11 respectively. The first two values were obtained for samples neutralized with NaOH solution, while the last two values were obtained for sample neutralized with KOH solution. Also, the saponification and peroxide values show a marked reduction when compared with values from the other samples, though the standard values as given by the AOCS and BSI for fats & oil are meant to be 0.05%max for FFA. The implication of high value of free fatty acid (FFA) lies in the fact that the oil can easily go rancid and this can lead to low shelf life. Also, high saponification and peroxide values shows that the oil is adulterated so therefore it cannot be consumed i.e. its edibility is not guaranteed. It also indicates the deterioration of the fats thereby producing unpleasant odour in the oil.

In the bleaching stage, the samples were bleached with fuller's earth and activated charcoal separately. In the case of fullers earth, on its addition to oil, there was a marked change in colour within a few minutes and at a low temperature but on further heating, there was a deviation from the normal yellowish colour of oil which is the standard colour to a somewhat whitish yellow colour and this was as a result of a longer time of heating at a high temperature and the bleaching agent was very active on all of the samples. But in the case of activated charcoal, it took a longer time for it to have an effect on the oil at the initial stage, but after sometimes, there was a marked change in the colour of the oil from a bright yellow into a yellow colour but it was most active on the Agric specie that were neutralized with potassium hydroxide.

Finally, physical examination of the deodorized oil shows that there was reduction in the odour after the operation was carried out.

CHAPTER FIVE

5.0 Conclusion and Recommendation

5.1 Conclusion

Finally, in this project work, it can be concluded that the Agric specie yield more oil than that of local specie.

It was concluded that palm kernel seed can be used in the manufacture of soap.

Also, the refined samples can be consumed since the value of the free fatty acid, saponification and peroxide value had been reduced to the bearest minimum thus, it is an indication that the oil is neither adulterated nor rancid because a rancid or adulterated oil will have high values of saponification, free fatty acid and peroxide value respectively.

Furthermore, fuller's earth and activated charcoal used in this work as bleaching agent can be used in bleaching oil but for a quick action on the oil samples and to avoid waste of money and energy; fuller's earth is highly recommended for large scale production.

5.2 RECOMMENDATIONS

Based on the results of this study, the following recommendations are made;

- For local/ home consumption, this project can be embarked upon but on improved condition of production.
- Facilities that can aid better project research should be made available so as to have better results and products.
- For better results, analysis of the refined samples should be carried out immediately after the whole process.

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APPENDIX

Analytical test results for the Local and Agric Crude Samples.

The percentage Oil yield was carried out on the Local and Agric crude palm kernel oil together with their qualitative analysis results were given below:

(a) Local specie

Weight of palm kernel crushed = 25kg

Palm kernel oil produced = 10.5lit = $0.0105m^3$

Density of PKO = $913.3kg/m^3$ (from the specific gravity)

But, density = $\frac{\text{Mass}}{\text{Volume}}$

Mass of oil = Density of oil × Volume recovered

$= 913.3\ kg/m^3 \times 0.0105\ m^3$

$= \underline{9.589kg}$

$\%\ \text{Yield} = \frac{\text{Crude PKO produced}}{\text{Palm kernel crushed}} \times \frac{100}{1}$

$= \frac{9.589kg}{25kg} \times \frac{100}{1} = 38.36\%$

The percentage of oil yield in local specie = 38.36%

(b) Agric specie

Weight of palm kernel crushed = 11kg

Palm kernel oil produced = 5.25lit = $0.00525m^3$

Density of PKO = $932.8kg/m^3$ (from the specific gravity)

$$\text{But, density} = \frac{\text{Mass}}{\text{Volume}}$$

$$\text{Mass of oil} = \text{Density of oil} \times \text{Volume recovered}$$

$$= 932.8\ kg/m^3 \times 0.00525\ m^3$$

$$= 4.897kg$$

$$\%\ \text{Yield} = \frac{\text{Crude PKO produced}}{\text{Palm kernel crushed}} \times \frac{100}{1}$$

$$= \frac{4.897kg}{11kg} \times \frac{100}{1}$$

$$= 44.52\%$$

The percentage of oil yield in Agric specie = 44.52%

PKO: Palm Kernel Oil.