QUALITATIVE ASSESSMENT OF TRADITIONAL AND MECHANIZED METHODS OF PROCESSING PALM OIL

By

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2004/18422EA

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FEBUARY, 2010

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BEING A FINAL YEAR PROJECT SUBMITTED IN PARTIAL FULFILLEMENT OF THE REQUIREMENTS OF THE AWARD OF BACHELOR OF ENGINEERING (B. Eng) DEGREE IN AGRICULTURE AND BIORESOURCES ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA,NIGER STATE

FEBUARY, 2010

DECLARATION

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or certificate of any university or institution .Information derived from personal communications, published and unpublished works of others where duly referenced in the text.

....

NAME OF STUDENT SIGNATURE AND DATE

CERTIFICATION

This project entitled "Qualitative Assessment of Traditional and Mechanized Methods of Processing Palm Oil" by Omotosho Lakimifa Seun 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.

16/02/10

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Date

9/2/2010

External Examiner

Date

DEDICATION

This project work is dedicated to the one who made me alive to write it. "No one but you Lord" thank you Lord.

ACKNOWLEDGEMENTS

I don't think I can thank God enough for seeing me through the beginning and the end of this project work.

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ABSTRACT

This project work focuses on the qualitative assessment and comparative analysis of traditional and mechanized methods of processing palm oil. Sample A (Traditional palm oil) was produced traditionally using soft oil process and sample B (mechanized palm oil) was obtained from NIFOR(Nigerian Institute For Oil Palm Research)Benin-Akure Road . Both samples were obtained in triplicates and analysed in the laboratory for the following parameters; such as saponification value, unsaponifiable matter, free fatty acids, moisture content, density, peroxide value, refractive index, appearance and colour. The result from the analysis of the parameters tested revealed that the sample A (traditional palm oil) have the parameters of saponification value, peroxide value refractive index and free fatty acid in accordance with NIS specification with the following average values, 96.37 (mgkoH/g), 9.6(mEq/kg), 1.463, and 2.88(%) respectively. Sample B have moisture content and density in accordance with the NIS specification with the following average values 1.3(%) and 0.959 (g/cm^3). Both samples have unsaponifiable matter and appearance and colour in accordance with NIS specification. Sample A having an average unsaponifiable value of 0.24 and appears as an orange viscous liquid, while sample B having value an average unsaponifiable value of 0.17 and appears as a brown viscous liquid.

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CHAPTER ONE

1.0. INTRODUCTION

1.1. Background Of Study

The Oil Palm, *Eleasis guinenssis* is a monocotyledon plant within the species E. *guineans,* different varieties and types can be distinguished that show definite characteristics with respect to the quality and quantity of the extractable oil. The simple classification of Oil Palm is based on its internal structure, especially the thickness of its shell, and the fruit form may belong to one of the following groups.

•**DURA:** These are fruits, which have thick shell. The shell is 2.8mm thick, comprising 20-25 percent weight; medium mesocarp content, 35-55 percent by mass. They are the most common type in the wild grooves.

•**TENERA:** These are fruits which have a thin shell surrounded by a fibre ring. The shell is 0.5-4mm thick, medium to high monocarp content, 60-95 percent.

• **PISIFIRA:** These are fruits, which have little or no shell at all, and the kernel is surrounded by a fibre ring. Their importance is found in the breeding of commercial palms (Asiedu, 1989, NIFOR, 1986).

The oil palm is largely cultivated in the equatorial regions of Africa, South East Asia and America. Of all oil bearing plants, oil palm is the highest yielding in the humid region of West Africa. Yield amount to about 4.5 Tonnes of oil per hectare per annum. Global production data for palm oil indicates that in 1985, slightly in excess of 6-7 million tones were produced. Major contributing countries are Malaysia, Philipines and Nigeria (Asiedu, 1989).

The soil and climatic condition with which palm fruits are best grown and with which elds are obtained from, are slightly acidic, loamy soil, rich in humus. Such soil retains ough water to maintain growth. Oil palm requires an annual rainfall of at least 1500mm, ich is well distributed throughout the year. The plant grows mainly in the high rainfall area n Nigeria, It constitutes the vegetation in parts of Imo, Cross River, Akwa Ibom and Rivers ates. Other areas include Anambra, Edo, Ondo and oyo states (Asiedu, 1989)

.2. Statement of Problem

The quality parameters of palm oil both mechanized and traditional produced are ffected by some effects such as delays between harvesting and processing, method of torage and bruising of fruits during harvesting.

.3. Aims and Objectives

. To determine the nutritional qualities of palm oil produced using the traditional method and the mechanized method.

2. To compare the nutritional qualities of palm oil produced using both methods

1.4. Justification of Study

The major objective of this project work is to asses the quality of both mechanized and traditional palm oil and to compare them in order to determine the extent to which they are affected by effects such as delays between harvesting and processing ,method of storage and bruising of fruits during harvesting.

1.5. Scope of Study

This work is an experimental one and so large quantitiess of palm oil cannot be produced. The quality parameters will be limited to the following quality parameters

Saponificaton Value, Unsaponifiable Matter Free Fatty Acids, Acid value, Moisture Content, Density, Peroxide Value, Refractive index and Appearance/Colour.

CHAPTER TWO

2.0. LITERATURE REVIEW

2.1. Various Methods of Producing Palm Oil

Onyeka Egbojor (2001), performed the quality evaluation of palm oil prepared from different traditional methods in Eastern Nigeria. Palm fruits used in the research were obtained from Imo State while the processed palm oil used for comparison was obtained from Adapalm Limited, Obaji, Imo State, Nigeria. Seven bunches of fully ripened fruits where processed using five different processing methods.

The processes where designated as Modern Mechanical Method (MMM), Fermented Fried Method(FFM),Sterilized Pressure Extraction Method (SPM),Sterilized Water Extraction Method (SWM), Air Fermentation Method (AFM) and Submerged Fermentation Method (SFM).

Oil extraction efficiency was calculated as the quantity of oil obtained as a percentage of the total (theoretical) oil content of the seeds(WEISS,1986) Moisture content, Percentage Free Fatty acid (FFA) and impurities were determined using the method adopted by Theme, 1986 FFA values of palm oil from the different processing methods were significantly different. Oil from SPM and MMM had the lowest level of FFA, approximately 2.5% and 4% respectively while sample from FFM had the highest (30.4%). The moisture content of oil from MMM, FFM and AFM are 0.1% while that from SPM, SWM and SFM are 0.16% 0.26% and 0.24% respectively. The oil from MMM, FFM and AFM compared quite favourably with the premium grade moisture specifications of 0.1-0.12% maximum. All samples except those from FFM and SFM exceeded the 0.01-0.05% specification. Oil from MMM and SPM are of good quality and could be used after certain levels of refining in food applications (Onyeka Egbojor 2001).

Ayodeji micheal (2006) did a nutritional analysis on palm oil. Four samples were processed mechanically and were obtained from laspotech farms Ikorodu Lagos; another four samples were obtained from ikoga in badagry central local government. And the average result of the mechanized and traditional samples for the following parameters are: saponification value(254.83 and 265.26)(mgKOH/g), peroxide value(5.10 and 4.30)(mEq/kg)(max), unsaponifiable matter(15.22 and 16.49)(g/kg)(max), free fatty acid(0.15% and 0.13%), moisture content (0.51% and 2.03%), density (0.911g/cm^3 and 0.918g/cm^3) and refractive index (1.4644 and 1.4641).The colour for the four mechanized samples is orange while for the four traditional samples are two brown and two yellow, from his result he concluded that the quality of palm oil can be improved by the series of unit operation involved in the method adopted beginning with the harvesting of oil palm bunch to the end of processing and that bruised fruit during harvesting produces oil with high rate of rancidity.

According to Hartley (1977), Palm oil, like other vegetable oils is a mixture of a number of different glycerides. For the identification of the characteristics or properties, of different oils and fats, a number of constants have been established. These constants are used as guides in the analysis and testing of oil and fats as well as in the assessment of their quality and purity; the most commonly used parameters to establish identity are melting and solidification temperatures, iodine value, saponofication value, refractive index, viscosity and density values. Other data sometimes determined to assess quality, include the free fatty acid content, peroxide value, moisture content and unsaponifiable matter.

Table 2.1: Ideal Composition of a Palm Fruit Bunch

Bunch	23-27kg
Fruit /bunch	60-65%
Kernel/bunch	5-7%
Oil/bunch	21-23%
Mesocarp/fruit	71-76%
Mesocarp/bunch	44-46%
Kernel/fruit	21-22%
Shell/ fruit	10-11%
Length of fruit	3-5cm long

Source: Kwasi (2002)

2.2. Composition of the Palm Fruit and Palm Oil

The palm fruit is composed of thick fibrous layer of pulp on the outside and a hard shelled kernel. It is rich in oil and extractable non-nitrogenous substances. Figure 1 shows the internal structure of a palm fruit.

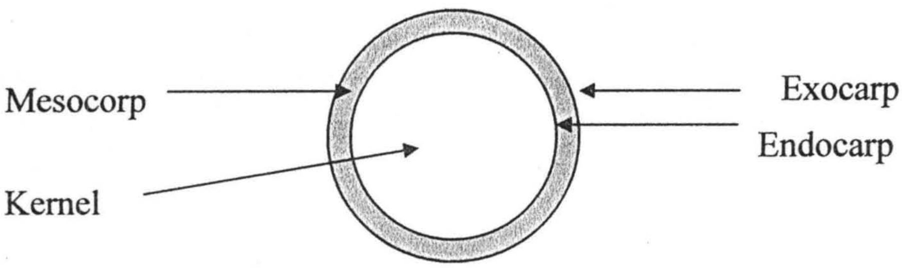

Fig.1: Internal Structure of a Palm Fruit

Source:Kwasi (2002)

Table 2.2: Composition of Palm Fruits

Constituent	Composition (%)
Oil	47-52
Moisture	6-8
Protein	7.5-9.0
Extractable non-nitrogenous substance	23-24
Cellulose	5
Ash	2

Source: Hartley (1977)

Palm oil which is derived from the outer pulpy layer of the palm fruits is composed mainly of palmitic acid (a saturated fatty acid). Generally on harvesting, fats in the mesocarp constitute 70-75 percent of the dry matter. In addition, there is about 1 percent palm oleic acid and traces of tauric acid (palm oleic acids apart from the fatty acids, the major constituents of palm oil are soluble carotenoids, chiefly carotene which give the palm oil its red coloration). The carotene content can be as high as 1000 ppm. The carotenoids are responsible for the high amount of vitamin A in palm oil (Asiedu, 1989). The percentage composition of the fatty acids of palm oil and their melting point are shown in Table 2.3.

Table 2.3: The Average Fatty Acid Composition of Palm Oil

Fatty acid	Composition (%)	Melting Point (^oC)
Saturated		
Stearic acid ((18)	4.3	69
Palmitic acid (16)	41.2	64
Myristic acid (14)	2.3	88
Unsaturated		
Linoleic acid	9.6	-5
Oleic acid	42.5	14

Source: Hartley, (1977)

2.3 General Processing Methods of Palm Oil

The most important part of the oil palm from the oil processors point of view is the palm fruits. The bunch is a large ovate fruit cluster, which contain many drops varying in colours from deep orange to dark-red-brown. When in full bearing, a palm may produce 12 bunches of fruits per year, the average weight of a bunch is 13-18kg. The unit operations involved in the processing of palm fruit into palm oil are sterilization, threshing or stripping, digestion, pressing and clarification.

2.3.1. **Sterilization**

Sterilization of palm fruits or bunches before oil extraction is achieved by boiling. The purpose of sterilization is to make stripping (separation of fruits from the bunches) easy, to disinfect the fruit by killing pathogens and to inhibit the action of lipolytic enzymes thus avoiding formation of free fatty acid. Sterilization may be carried out in drums or in sterilization chambers.

2.3.2. **Threshing or Stripping**

Individual fruits are removed from the sterilized bunch. The fruits may be re-sterilized for about 40 minutes before digestion. The fruit bunches are off loaded from the sterilizer and placed in the rotary stripper. The stripper is made to rotate by turning the handle in a clockwise direction. As the stripper rotates, it knocks about the bunch and the fruits drop off and are collected.

2.3.3. **Digestion**

The purpose of digestion as with pounding is to crush the fruit physically to yield a hot homogenous pulp. Digestion facilitates the liberation of oil from the cell of the mesocarp. Modern digestion chamber involves steam jacked cylindrical vessels with a vertical rotating shaft in the center, driven from the top. Attached to the shafts are pans of stirring ram with which the fruits are mashed. The temperature in the digesters must be maintained at around $90^{O}C$. It is important that the temperature does not rise to $100^{O}C$ because the water in the marsh must not be allowed to boil as this may cause turbulence in the digester as the boiling water may spill over the top.

2.3.4. **Pressing**

Crude oil is extracted from the hot fruit pulp by pressing, centrifugation or hot water solvent extraction. The pressing can be done using a hydraulic hand press. The hydraulic hand press is fairly portable equipment with such component, as cage, pump, piston and the sturdy frame with which channels from the digestion are placed in the perforated cage and filled to capacity; this is moved into the center of the frame work under the stationary piston. Using the pump, the filled up cage is elevated and rammed against the piston

2.3.5. **Clarification**

Crude oil from the pressing operation consists of oil, sugar dissolved in water, salt from the flesh of the fruits and cellular matter from the mesocarp (basically it contains oil, sludge, water and other impurities). Crude oil from the centrifuges contains about 40-50 percent water and from the screw press about 60 percent water.

In the traditional method of pressing, crude oil is clarified in the setting tank, containing water, and heated to about $95^{O}C$, pure oil is drawn or skimmed from the top and the impurities are allowed to settle down. Temperature over $100^{O}C$ tends to produce emulsion.

2.3.6. **Drying**

Clarified oil still contains a certain amount of water (less than one percent) and solid impurities. The oil is dried to lower the water content to about 0.1 to 0.2 percent. oil with more than1% water content have a shorter storage life (Asiedu, 1989).

2.4. **Traditional Methods of Processing Palm Oil**

The traditional methods of processing palm oil are of two types;

2.4.1. **Soft Palm Oil Processing Method**

Indigenous method of extractions consists of boiling, pounding or kneading and hand pressing as in Figure 2. The harvested bunches are cut into sections, sprinkled with water, covered with leaves and left for 2-4days. The fruits are then picked from the bunch sections, boiled for about 4 hours, pounded in wooden mortars until hot, crushed pulp of more or less even consistency is obtained. The pounded marsh is thoroughly shirred in hot water and the first crude oil, which rises to the surface, is skimmed off into another vessel. The remaining fibre is removed and boiled for several hours during which time any fibre left sinks to the bottom or is sieved out .The now relatively pure oil again skimmed and is then (fried or dried) in shallow pans to expel the last traces of water. The result is palm oil termed as soft oil, which is liquid at tropical temperatures. This long slow process results in poor quality and low yield. It is estimated that the efficiency of the method, (extracted oil to total oil in the fruits) is about 40-45 percent and the average free fatty acid content is 7-12 percent.

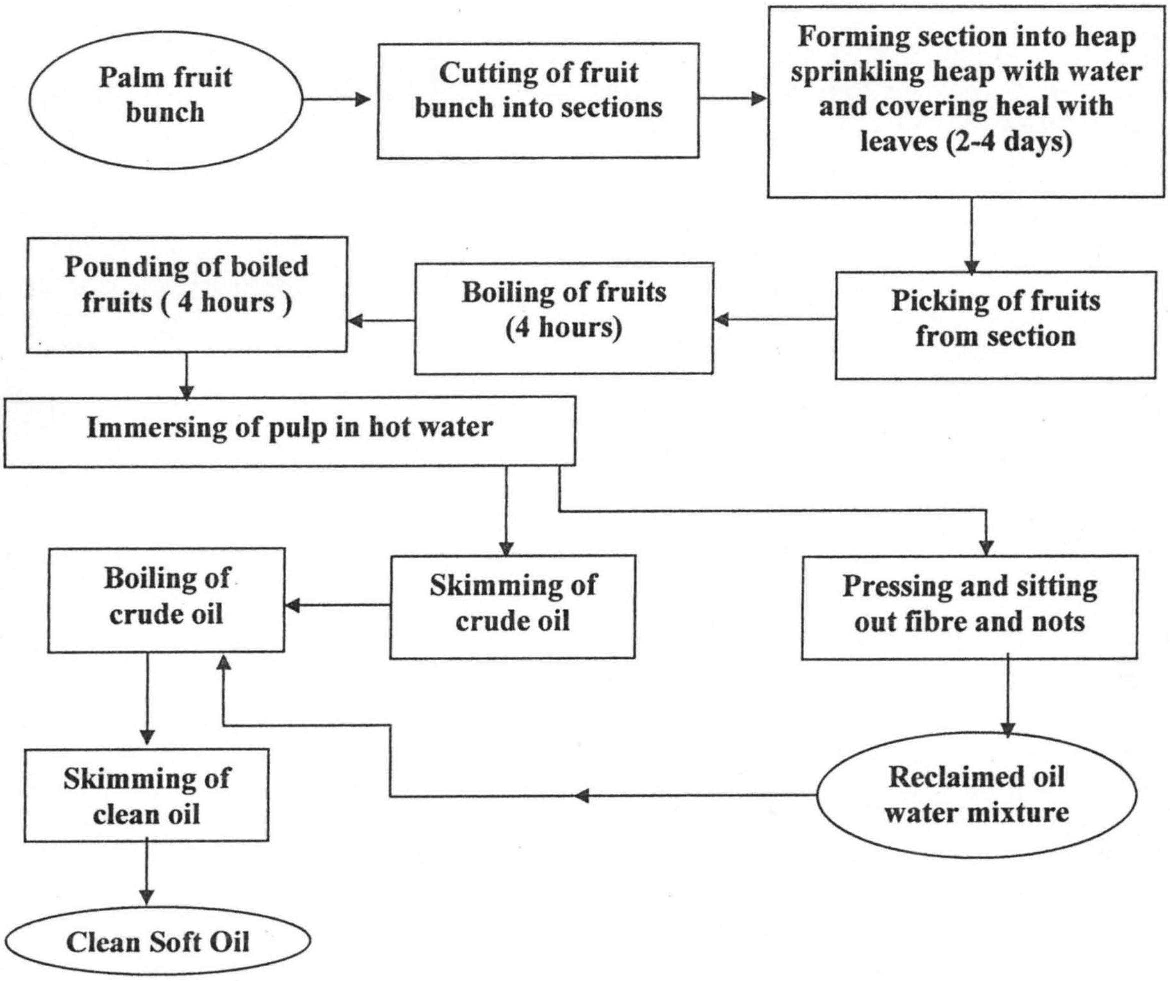

Fig 2: Flow chart for soft palm oil processing method

2.4.2. **Hard Palm Oil Processing Method**

In the hard oil process, as used in the Niger Delta, the fruits are put in a pit for several days. Fermentation caused by microbial enzyme action takes place with the production of heat and the fruits thus become softened. After three days they are trodden vigorously in floored French. The oil are drained off, skimmed and boiled. Oil obtained from this method remains solid even at 32^0C hence the term 'hard' oil. The efficiency is reported to be between 20-30 percent. Hard oil contains as much as 18-22 percent free fatty acids, most of which are formed during fermentation. Both methods of extracting oil are time-consuming, inefficient and lead to the production of oil with a high free fatty acid content.

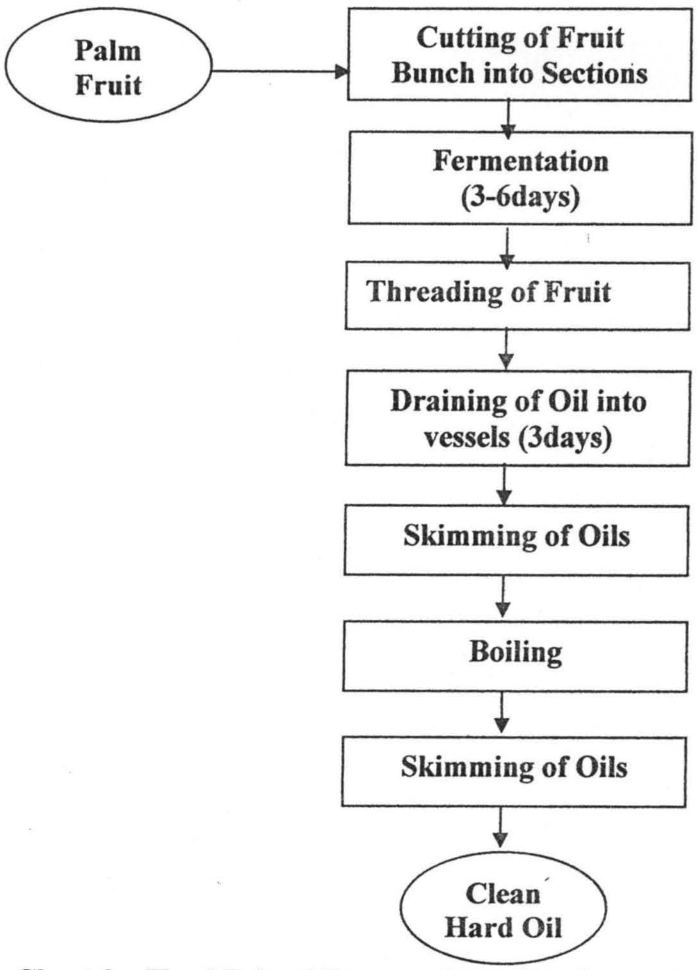

Fig 3: Flow Chart for Hard Palm Oil processing method Source: Asiedu (1989)

2.5. Mechanized Method of Processing Palm Oil

The production is a modern mill consisting of steam and power generation, sterilization, mechanical stripping, fruit digestion, oil extraction and oil clarification. Steam is used extensively in oil mills and is generated on site using the oil palm by-products, fibre and shell, as fuel. Most palm oil mills generate all or at least part of their power by utilizing steam turbines.

Sterilization is carried out in a pressure vessel where the fruit bunch is subjected to steam of sufficient pressure for about 70 minutes or more, thus, facilitating the softening of the pericarp and increasing oil recovery during digestion. Pressing/separation of the individual fruits from the branches is done mechanically. The mechanical stripper, as the equipment is called, is a rotating drum with perforations in the periphery just wide enough for the stripped fruits to pass through. The empty bunch exits from the open end of the drum into a conveyor that passes it to the incinerator, in the incinerator, the empty bunch is burnt to produce ash which may be used as fertilizer or as an ingredient in soap making due to its high potash content. The separated fruit is conveyed into the digester, a cylindrical vessel with a steam jacket. It is open at the top and is connected at the bottom of the press via chute. The aim of fruit digestion is to break up the fruits physically by means of beater arms and to raise the temperature of the digested pulp to about 90^0c. This facilitates easy extraction of oil in the press from the digester; the hot mashed pulp is fed into the press where oil extraction occurs.

Various types of presses may be used in the modern oil mill; the double screw expeller is mostly used. It consists of a perforated cage, two helical screws, two cones, a hydraulic pump and a drive mechanism. The two screws are located inside the case and revolve in opposite directions.

The digested marsh is pressed by the screw, while the cones operated by the pump provide the necessary pressure in the opposite direction in this manner; the oil-water mixture is squeezed out through the perforations in the cage.

The crude oil from the press or expeller is fed into a clarification tank where steam is added to raise the temperature and reduce the viscosity for better separation. Separation of oil from water and sludge occurs faster when the temperature of the crude oil is raised to about 95^0C and as oil has a lower density; it rises to the top of the tank. The top oil is recovered and then passed through a heater to raise the temperature for the purifier, in the purifier, the remaining dirt is removed and the clean oil is then fed into a drier to reduce the Moisture content. From the drier, the oil is pumped to the main storage tank.

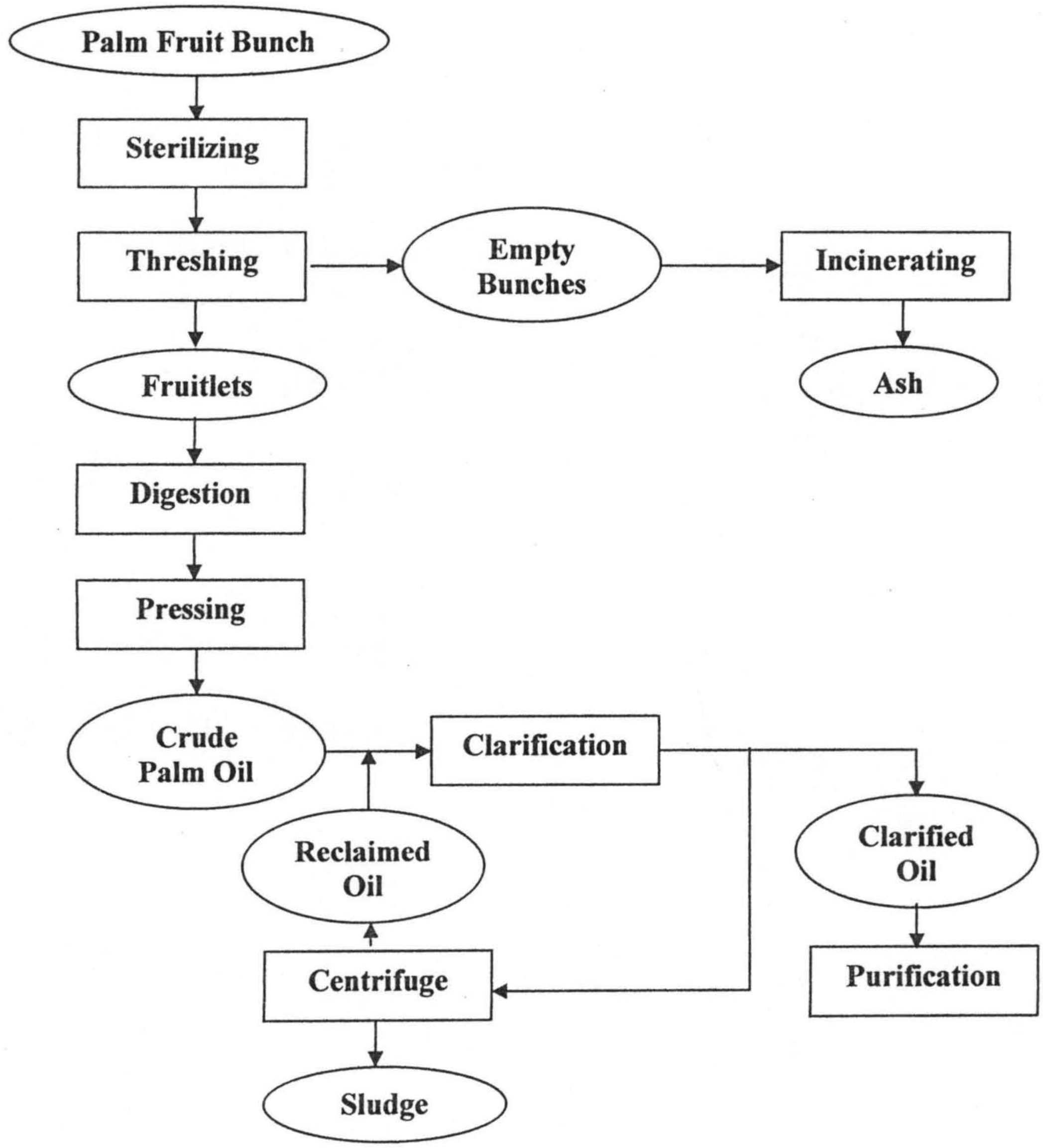

Fig: 4: Flow Chart for Mechanized Palm Processing

Source: Asiedu (1989)

2.6 **Environmental considerations**

2.6.1 **Treatment of solid waste products**

In a well run palm oil mill, it is expected that each 100 tonnes of(Fresh fruit bunch) FFB processed yields 20 to 24 tonnes of crude palm oil and about 4 tonnes of palm kernels. Thus between 72 to 76 percent of the FFB comes out at various stages of the process as waste.

The solid wastes that result from the milling operations are:

- Empty fruit bunches,
- Palm fibre, and
- Palm kernel shell.

In the large and medium-scale mills the above-mentioned waste products are all put to economically useful purpose. They could therefore be referred to as by-products rather than waste products.Wet, empty bunches are partly dried in the sun and later used as fuel. Another economic use for the empty bunches is to return them to the plantation as a mulch to enhance moisture retention and organic matter in the soil. The palm kernel shell is also used as a source of fuel for the boilers. Unfortunately the shell contains silicates that form a scale in the boilers if too much shell is fed to the furnace, thus limiting the amount of shell that can be utilized in the boilers. Residual shell is disposed of as gravel for plantation roads maintenance. Blacksmiths also buy the shells to use as fuel material in their casting and forging operations. Palm nut shell is also used in the preparation of pozzolana, a cement substitute material that has been developed by the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana.

The fibre recovered from the nut/fibre separation stage is a good combustible material and finds ready use as fuel to boil the fruit. The fibre constitutes the bulk of material used to fire the large boilers used to generate superheated steam to drive turbines for electrical power generation in large-scale plants.Boiler ash is recycled as fertilizer and factory floor cleaning agent. The potash in the ashes reacts with the oil to form a weak potash soap that is washed away with water.Small-scale mills also use the fibre and bunch waste as fuel material. Most small-scale mills do not undertake the shelling of recovered palm nuts. The nuts are sold to palm kernel processors.Small-scale palm kernel processors use clay baths to separate kernels from shells. The shells are normally left in a pile to dry. Some of the shells are used for fuel but there are always residual amounts found around the palm kernel processing centres. Periodically the pile is removed and used as landfill.Wood consumption of small-scale operations is relatively small because of the recycling of the fibre and bunch waste as the main fuel source. The medium-scale operators tend to supplement their internally generated solid waste fuel sources with wood for firing their boilers. The impact on the local tree population is significant enough to cause factories to close while foraging for wood supplies.

2.6.2 **Treatment of aqueous effluent**

Large- and medium-scale mills produce copious volumes of liquid waste from the sterilizer, clarifying centrifuges and hydrocyclones. This effluent must be treated before discharge to avoid serious environmental pollution Liquid waste treatment involves anaerobic fermentation followed by aerobic fermentation in large ponds until the effluent quality is suitable for discharge. In some of the mills the treated effluent is used on the farm as manure and source of water for irrigation. The sludge accumulating in the fermentation ponds is periodically removed and fed to the land. To manage the amount of oil entrained in the effluent, while at the same time improving the efficiency of oil recovery, the large mills use de-watering and decanting centrifuges at various locations in the process line.

When it comes to liquid waste management most traditional processors and small-scale palm oil processors do not adhere to any environmental protection practices. The environmental awareness level of the operators in this industrial area is low. Indeed much is desired of the hygiene of most facilities. Traditional processors operate so close to nature that they simply return liquids to the surrounding bushes. The discharged quantities are so small that the ground easily absorbs the waste matter and the operators have not yet seen their activities as injurious to their surroundings. However in the more organized intermediate technology mills sludge from the clarifying tanks are carried in buckets or rudimentary gutters to sludge pits dug in the nearby bushes. When the sludge pit begins to give off a bad odour the pit is filled in and another one dug for the purpose. Charcoal from the cooking fires is dumped into the pits to absorb some of the odour. Sometimes the oil in the sludge pit is recovered and mixed with fibre to make a fire-starting cake called 'flint'. It has been observed that when the small-scale mill operators empty their sludge on the surrounding bushes the bushes slowly die. Operators say they use the sludge as a herbicide to clear their surroundings. It is, however, time to develop simple inexpensive aqueous pollution control systems for small-scale operators.

Environmental pollution considerations in small-scale palm oil milling need concentrated attention as this industrial segment assumes greater importance. It is hoped that as more educated people come into the industry they will bring increased awareness and a greater commitment to adopt improved environmental management practices in their operations. (www.fao.org)

2.7 Nigeria Industrial Standard (NIS) of Palm Oil Specification

Table 2.4 shows the standard value of basic parameters for the determination of palm oil quality.

Table 2.4: Standard Value of Basic Parameters for Palm Oil Quality Determination

PARAMETERS	NIS SPECIFICATION
Specification value	195-205 (mg KOH/g)
Peroxide value	10 max
Free fatty Acids	3.5 max
Moisture content	0.2 max
Density	0.898-0.900(g/cm^3)
Refractive index	1.4600-1.4650 at 26.6^{0}c
Unsaponifiable matter	10(g/kg) max
Appearance and Colour	Yellow-Orange to Dirty-Brown

Source: NIS (2000)

2.8 Storage of Palm Oil

The refined palm oil containing low free fatty acids (FFA) stores well if it stored in non-metallic containers and is not exposed to air and light. Hartley (1977) stated the following requirements for the production of low FFA palm oil having good storage property.

1. Minimum bruising of the fruits during harvesting, carriage and movement of the mill site.
2. Minimal time between harvesting and sterilization.
3 oil extracted does not cool down, avoid contact with apparatus or materials causing recommencement of lypolysis during extraction. (Salunkhe, 1986)

While enzymatic action is the major causes of rise in FFA between harvesting sand processing, research has shown that after destruction of enzymes, the stored oil can still deteriorate through autocatalytic hydrolysis (Loncin, 1963). The stored oil can also deteriorate due to the action of lypolytic micro- organisms. Desassis, (1957) demonstrated that with palm oil stored in drums in Dahomey, the FFA rise was greater than could be expected from auto-catalytic hydrolysis; Research has shown that increased hydrolysis of palm oil can be brought about by infection with lypolytic micro-organisms (Coursey, 1963), the sample of oil examined in Nigeria showed the presence of some important species of lypolytic fungi, namely, *Paccilomyces, Aspergillus, Rhizopus* and *Totula.* An inoculation experiment demonstrated that additional rises of FFA of the order of 1 to 3% could be induced during a storage period of 8 weeks. With drum storage, variation from the autocatalytic reaction has been most common at the lower temperatures, suggesting that the biochemical factors are unlikely to be important where storage at high temperature is the rule. The final milling operations must ensure a water content of less than 0.1%. The dirty content must also be reduced; clean and sterile conditions must be maintained in order to avoid contact of oil with lypolytic organism (Hartley, 1977)

CHAPTER THREE

3.0. MATERIALS AND METHODS

3.1. Materials

The materials used for the extraction of palm oil, using soft oil process are as follows;

- Mortar
- Pestle
- Metallic pot
- Bowl
- Digital weighing balance
- Water
- Stop watch
- Electric Stove
- Tray
- The oil palm
- Glass container

The *Tenera* variety of oil palm was used for this project

3.2. Methods of Extraction

There are two types of method

- The traditional method
- The mechanized method

The traditional method (soft oil process) was used for this project.

3.2.1. **Traditional Method of Extraction**

The oil palms were weighed using digital weighing balance. The measured oil palm fruits were washed and poured into a metallic pot filled with water and placed on an electric cooker set at 250^{O}C. The boiling process lasted for 3 hours. The fruits were then removed and spread on a tray to allow cooling to take place. This lasted for 1 hour after which the fruits were placed in a mortar and pounded to strip off the pulpy layer. Water was poured into the pounded marsh and stirred thoroughly, crude palm oil was observed at the top, and this was skimmed with a bowl and poured in the pot and allowed to boil for 30 minutes. Traces of water were still present and the oil was skimmed again from the top and poured into the glass container and the glass container was tagged A.

The weight equation of the process is as follows;

Weight of oil palm (1610g)= weight of palm oil (303.41g) + weight of shaft after drying (203.22g) + weight of nuts after drying (851.56g)

3.2.2 Mechanized method of extraction

The mechanized oil sample was gotten from NIFOR(Nigerian Institute For Oil Palm Research) Benin-Akure road. Small quantity was collected and the sample was weighed with an analogue weighing balance .The result of the weight is 320g and the container was tagged B.

3.3. **Method of Experiments**

3.3.1. **Saponification Value Determination**

The saponification value of an oil or fat is defined as the number of milligram (mg) of potassium hydroxide required to neutralize fatty acids resulting from the complete hydrolysis of 1g of the sample.

Alcoholic solution of potassium hydroxide (35-40g) was dissolved in 20ml of water and diluted to 1 litre with alcohol (95%), this was allowed to stand overnight and the clear liquid was decanted.

2g of the oil was weighed into a conical flask and exactly 25ml of the alcoholic potassium hydroxide solution was added. Reflux condenser was attached and the flask was heated in boiling water for 1 hour, shaking frequently. 1ml of phenolphthalein (1%) solution was added and titrate hot the excess alkali with 0.5M hydrochloric acid (titration = a ml). A blank was also carried out at the same time (titration = b ml). (Pearson, 1978).

$$\text{Saponification Value} = \frac{(b-a) \times 28.05}{\text{Wt(g) of Sample}}$$

3.3.2. **Peroxide Value Determination**

The peroxide value is a measure of the peroxides contained in the oil. 10ml of chloroform and 10ml of glacial acetic acid were added into the flask and a micro gas flame was used to close the flask, the mixture was boiled to the top of the tube where it was condensed by the water jacket, the mixture was boiled steadily; 1g of potassium iodide was dissolved in 1.3ml of water slowly down the condenser so that the refluxing was not interrupted. Any precipitated iodide was re-dissolved by adding not more than 0.3ml water. Then 1g of the sample was added down the condenser again without interrupting the refluxing. The condenser water was turned off so that the entire sample was washed into the flask. The mixture was boiled for further 4 minutes. Then the flask was removed, cooled rapidly and 50ml of water was added. The liberated iodide was titrated with 0.01m sodium thiosulphate using starch. (Pearson, 1978).

$$\text{Peroxide value} = \frac{V_1 - V_O \times T \times 100}{M}$$

V_O = Volume of the sulphur used for blank

V_1 = Volume of the sulphur used for sample

T = The normalily of $Na_2S_2O_3$

M = Mass of test sample used

3.3.3. **Unsaponifiable Matter Determination**

Unsaponifiable matter can be defined as the material present in oils and fats which after saponification of the oil or fat by caustic alkali and extraction by a suitable solvent remains non-volatile on drying at $80^{O}C$. The unsaponifiable matter includes hydrocarbons, higher alcohols and sterols (cholesterol phytosterol).

After the titration of the saponification value, the neutralized liquid alkaline was made again with 1ml of aqueous 3M potassium hydroxide solution, transferred to a separator and washed with water (50ml less than the volume of 0.5M hydrocholoric acid used). The solution was extracted while still warm 3 times with 50ml quantities of diethyl ether. Each ether extracted was poured into another separator containing 20ml of water. After the third extract had been added, the ether extracts were combined with the first 20ml quantities. The ether extract was washed twice with 20ml of aqueous 0.5M potassium hydroxide solution and at least twice with 20ml quantity of water until the wash water was no longer alkaline to phenolphthalein. The ether extract was poured into a weighed flask, the solvent was evaporated off, the residue dried at not more than $80^{O}C$ and weighed to constant weight. (Pearson, 1978).

Unsaponifiable matter is expressed as: $\frac{100\,(M_1 - M_2 - M_3)}{M_O}$

M_O = Mass of test sample

M_1 = Mass of residue

M_2 = Mass of residue obtained with blank

M_3 = Mass of fatty

3.3.4. **Free Fatty Acids (FFA) And Acid Value**

The acid value of an oil or fat is defined as the number of milligram (mg) of potassium hydroxide required to neutralize the free acid in 1g of the sample. The result is often expressed as the percentage of free acidity. The acid value is a measure of the extent to which the glycerides in the oil have been decomposed by lipase action.

25ml diethyl ether with 25ml alcohol and 1ml of phenolphthalein solution (%) was mixed and carefully neutralized with 0.1M sodium hydroxide. Then 10g of the oil was dissolved in the mixed neutral solvent and titrated with aqueous 0.1M sodium hydroxide shaking constantly until a pink colour, which persisted for 15 seconds, was obtained. (Pearson, 1978).

$$Acid\ value = \frac{Titration\,(ml) \times 5.61}{Wt.of\ sample\ used}$$

$$FFA \text{ palmitic acid} = \frac{Titre \times 0.0256 \times 100}{Wt.of\ sample\ used}$$

The FFA figure is usually calculated as oleic acid (1ml 0.1M sodium hydroxide = 0.0282g oleic acid), in which case the acid value = $2 \times FFA$.

3.3.5. **Moisture Content Determination**

Moisture content is the percentage of water and volatile matter present in the oil. The Petri-dish containing activated sand was weighted a. The sample of the oil was spread over the activated sand in the Petri-dish and weighed b. Then this was oven dried for about 2 hours at 105OC. It was then cooled inside the desiccators and weighed c. Dual experiment was done for each of the sample for accuracy and the average for the moisture content percentage calculated (Williams, 1966)

$$\%\ Moisture\ Content = \frac{Weight\ loss \times 100}{Weight\ of\ sample}$$

$$=\frac{(b-c)\times 100}{(b-a)}$$

3.3.6. Density Determination

Normally the relative density (weight/ml) is determined at 20^{O}C. The density bottle (which has a ground glass stopper with a fine hole through it) was weighed empty (E), then filled with the distilled water and weighed (D). Having cleaned the bottle well, it was filled with the oil sample and weighed (S). The density was calculated as below; (William, 1980).

$$Density = \frac{\text{(Weight of sample + bottle) - (Weight of empty bottle)}}{\text{(Weight of distilled water + bottle) - (Weight of empty bottle)}}$$

$$=\frac{S-E}{D-E}(g/cm^3)$$

3.3.7. Colour and Appearance Determination

This was done by visual inspection method. The colour and the appearance of each of the oil samples were observed, compared with standard chart and recorded.

3.3.8. Refractive Index Determination

Abbe refractometer was used to determine the refractive index of the samples at 26.6^{O}C.Tthe prism was slightly opened by turning screw head and few drops of sample were dropped into the funnel shaped aperture between prisms. The prism was closed firmly by tightening screw reading, so that temperature of sample and instrument will be the same. Methods of measurement are based upon observation of position of borderline of total reflection in relation to faces of flint glass prism. The border line was brought into field of vision of telescope by rotating double prism by means of alidade in the following manner: the sector was held firmly and moved alidade backward or forward until field of vision is divided into light and dark portion. Line dividing these portions is "border line" and as a rule will not be sharp line but band of colour. Colours are eliminated by rotating screw head compensator until sharp, colourless line is obtained. The borderline was adjusted so that it falls on point of intersection of cross hairs. (William, 1980).

CHAPTER FOUR

4.0. RESULTS AND DISCUSSION

4.1. Results

The experimental data obtained from the tests carried out on the two samples are as shown in Table 4.1 below. The mechanically extracted oil sample was processed on 11th of November 2009 and the traditionally extracted oil sample was processed on 9th of November 2009. The experiments for the determination of the quality parameters were carried out in Triplicates and these are shown on Table 4.1.

Table 4.1: Triplicates of the Quality Parameters of the mechanically and traditionally extracted oil samples

Parameters	Traditionally Extracted Palm Oil			Mechanically Extracted Palm Oil		
	1	2	3	1	2	3
Saponification value	196.35	196.49	196.35	188.35	188.35	188.08
Peroxide value	9.9	9.9	8.9	10.4	10.4	10.4
Free-fatty acid	2.94	2.382	2.89	12.16	12.16	12.35
Moisture Content	2	2	2	1.2	1.2	1.2
Density	1.033	1.033	1.032	0.958	0.958	0.960
Refractive index	1.46	1.47	1.46	1.44	1.44	1.46
Unsaponifiable matter	0.17	0.38	0.17	0.17	0.17	0.17
Appearance and Colour	Orange Viscous Liquid	Orange Viscous Liquid	Orange Viscous Liquid	Brownish viscous Liquid	Brownish viscous Liquid	Brownish viscous Liquid

Table 4.2: Mean Values of the Quality Parameters of the Extracted Oil Compared with the NIS Specification

Parameters	Method	N	Mean	NIS Specification
Saponification Value	Traditional	3	196.37	
	Mechanical	3	188.26	195-205(mgkoH/g)
Peroxide Value	Traditional	3	9.6	
	Mechanical	3	10.3	10(mEq/kg) Max
Moisture Content	Traditional	3	2	
	Mechanical	3	1.3	0.2 max
Density	Traditional	3	1.033	
	Mechanical	3	0.959	0.898 – 0.900(g/cm^3)
Refractive index	Traditional	3	1.463	1.4600 – 1.4650 at
	Mechanical	3	1.45	26.6^{O}C
Unsaponifiable matter	Traditional	3	0.24	
	Mechanical	3	0.17	10(g/kg) (max)
Free Fatty Acid	Traditional	3	2.88	
	Mechanical	3	12.27	3.5 Max (%)
Appearance and Colour	Traditional	3	Orange Viscous Liquid	Yellow – Orange to dirty Brown
	Mechanical	3	Brownish Viscous Liquid	

4.2. Discussion of Results

4.2.1. Saponification Value

The saponification value of both traditional and mechanical samples are 196.37 (mgKOH/g) and 188.26 (mgKOH/g) respectively. The traditional oil falls within the NIS specification standard and the mechanized oil slightly below the NIS specification standard.

A lower result was gotten when compared to that of Ayodeji (2006) which obtained values of 254.83(mgKOH/g) and 265.26(mg KOH/g) for the mechanized and traditional samples respectively. Saponification value is a measure of both free and combined acids. The saponification value is inversely proportional to the mean molecular weight of the fatty acids in the glycerides present.(Gregory1996).

This implies that the oil obtained from this project work is heavier and this is due to the method of production which is a major determinant of the free fatty acids present in palm oil.

4.2.2. Peroxide Value

The peroxide value of both samples are 9.6(mEq/kg)(max) and 10.3(mEq/kg)(max) for the traditional and mechanical respectively; when compared with the NIS specification of 10(mEq/kg)max, it can be seen that the traditional palm oil falls within this specification standard and the mechanized palm oil is slightly above it. A higher result was gotten when compared to that of Ayodeji (2006) which obtained values of 5.10(mEq/kg)(max) and 4.30(mEq/kg)(max) for mechanized and traditional samples respectively. Fats undergo changes during storage which result in production of an unpleasant taste and odour which is commonly referred to as rancidity. Rancidity is caused by the action of air (oxidation rancidity) or by micro organism (ketonic rancidity.) peroxide value is used to monitor the development of rancidity the quantities of peroxides generated in the product. The peroxide value is usually less than 10 per gram of sample when the sample is fresh during storage of most parts peroxide value shows little increase in the early stages.(Gregory 1996).

This implies that the oil obtained from this project work is not as fresh due to method of storage (it wasn't stored properly) or it was stored for a longer period of time, if the samples obtained from the project work was left untouched for some days it will become rancid.

4.2.3. **Free Fatty Acid**

The free-fatty acid of both traditional and mechanized samples are 2.88% and 12.27% respectively, when compared to the NIS specification of 3.5% max it can be seen that the traditional palm oil falls within the NIS specification standard and the mechanized palm oil is above it. This may be as a result of long time between harvesting and processing.Comparing the result gotten to that of Onyeka (2001) who obtained different values from different methods with SPM and MMM having lowest level of FFA, approximately 25% and 40% respectively while samples from FFM had the highest result 30.4%, it implies that FFA depends on the method of production.

The acid value measures the extent the glycerides in the oil have been decomposed by lipase action. The decomposition is accelerated by heat and light. As rancidity is usually accompanied by free fatty acid formation the determination is often as a general indication of the condition and edibility of the oil.(Gregory1996) .This implies that the lower the FFA the more edible the oil. A high FFA may be as a result of long time between harvesting and processing.

4.2.4. **Moisture Content**

The average moisture contents for both traditional and mechanized samples are 2% and 1.3% respectively. None of the two samples fell within the NIS specification of 0.2%max.Comparing the result with that of Onyeka (2001) who obtained moisture of oil for MMM, FFM and AFM to be 0.1% while that for SPM, SWM and SFM to be 0.16%, 0.26% and 0.24% respectively. This implies that moisture content depends on the method of production. Moisture content is the percentage of water present in oil (Williams 1966). High moisture content indicates the presence of high amount of water and due to this sample with high moisture content may not be able to store for a long period of time before going bad.

4.2.5. **Density**

The density of both traditional and mechanized palm oil are 1.033 (g/cm^3) and 0.959(g/cm^3). The mechanized palm oil sample was closer to the NIS specification of 0.898 – 0.900(g/cm^3)While the traditional palm oil sample was farther from the specification, this could be as a result of impurities in the palm oil, which increased the density. Comparing the result gotten to that of Ayodeji (2006) who got average values of 0.911(g/cm^3) and 0.918(g/cm^3) for the mechanized and traditional samples respectively. It is observed that the results are relatively close. A high value in density in the mechanized palm oil could be a result of impurities in the palm oil. Density is also dependent on the variety of the oil palm used i.e Dura, pisifira and tenera.

4.2.6. **Refractive Index**

The refractive index of both samples is 1.463 and 1.45 at $26.6^{O}C$ for the traditionally and mechanically extracted oils respectively. The traditional oil falls within the NIS specification standard of 1.4600 – 1.4650 at $26.6^{O}C$, while the mechanized oil falls slightly below the NIS specification standard. It is observed that the result of this project work is relatively closed to that of Ayodeji (2006) who got average values of 1.4644 and 1.4641 at 26^0C,the small difference may be due to the slight difference in temperature(0.6^0C difference in temperature). A correction factor can be included where it is not possible to work at the stipulated temperature. Cocks and Rede (1966) prescribed the following formular for this:

Refractive index = R +0.00380ϴ

Where R = refractometer reading.

ϴ = number of degrees in centigrade by which the measurement temperature is above the specified temperature.

Refractive index also correlates with iodine value and saponification value according to equation enunciated by Swan Oon(Sountag,1979)

$$\text{Refractive index} = 1.4643 - 0.0000665 - \frac{0.0096A}{S+0.0001171I}$$

Where S = saponification value

A = acid value

I = iodine value

Refractive index also depends on the density because refraction in light is the result of the wave slowing down as it enters a denser medium or speeding up as it enters a less dense medium(Okeke 2005).

4.2.7. Unsaponifiable Matter

The average of the two processing methods used, has a lower unsaponifiable matter of 0.24(g/kg) for traditional and 0.17(g/kg) for mechanized when compared with the NIS standard of 10.00(g/kg)max.

Comparing this result with the 0.15 and 0.16 gotten by Ayodeji (2006) it is observed that the result of this project work is higher. The lower the unsaponifiable matter the lower the water insoluble components and the lower the level of contamination of the oil. This implies that the samples used in this project work were not properly stored.

4.2.8. **Appearance and Colour**

Apperance and colour result was obtained through visual inspection with a colour chart. The appearance and colour of each of the oil samples can be said to be within the NIS specification of yellow-orange to dirty brown.

The result gotten from Ayodeji (2006) also falls within the NIS specification. The colour of the palm oil is dependent on the method adopted in processing and the variety of oil palm used.

CHAPTER FIVE

5.0. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

Based on the results obtained, it can be concluded that the oil sample from the traditional method gave better results in terms of quality in the following parameters; Saponification value, Peroxide value, Free fatty acid and Refractive index while the oil sample from the mechanical method had better quality in Moisture content, Density and Unsaponifiable matter.

5.2. Recommendations

Based on the study carried out in this project work the following recommendations where made:

1.) The quality parameters investigated in both mechanized and traditional methods of processing oil palm fruits may be improved upon, by shortening the time between harvesting and processing. Unnecessary delay of oil palm bunch on farm for two to three days after harvesting or before processing into palm oil should be discouraged.

2.) It is observed that most palm oil available for sale are often mixed with additives which affect the nutritional qualities of the palm oil and could be harmful if consumed in large quantities so it is recommended that palm oil produced should pass through regulatory bodies for efficient analysis before being distributed and sold. Further work should be done on the effects of different additives on palm oil.

3.) During the processing of traditional palm oil the digestion phase was very tedious which involves pounding manually which requires strength and skill of the operator. Further work should be done on producing a portable digester which will increase the comfort, ease and efficiency of the operator.

4.) Mechanized and traditional palm oil deteriorate depending on the method of storage used. Further work should be carried out on the effect of storage on the quality of the palm oil produced from both methods and the methods of storage should be compared.

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APPENDIX

The results of the experiments carried out are shown in the tables below.

1. **Saponification Value**

Table 1: Results of Moisture Content Determination

	TRADITIONAL			MECHANICAL		
	1	2	3	1	2	3
Titre Value	10.05	10.04	10.05	10.65	10.62	10.64

Weight of sample in (g) = 1g

The titre value of blank solution (b) = 24.05ml

$$\text{The saponification value} = \frac{(b-a) \times 28.05}{Wt\ (g)\ of\ sample}$$

2. **Peroxide Value**

Table 2: Results of Peroxide value Determination

	TRADITIONAL			MECHANICAL		
	1	2	3	1	2	3
Titre Value	1.0	1.0	0.9	1.05	1.03	1.05

Normality of $Na_2S_2O_3$ = 0.01m

The titre value of blank solution = 0.01

The weight of the sample in (g) = 1g

$$\text{Peroxide value} = \frac{V_1 - V_o \times T \times 100}{m}$$

3. **Free Fatty Acid**

Table 3: Results of Free Fatty Acid

	TRADITIONAL			MECHANICAL		
	1	2	3	1	2	3
Titre Value	11.50	11.0	11.3	47.5	48.0	48.3

Weight of sample in g = 10g

Free fatty acid FFA = $\frac{Titre \times 0.0256 \times 100}{wt\ of\ sample}$

4. **Moisture Content**

Table 4: Results of Moisture Content Determination

	TRADITIONAL			MECHANICAL		
	1	2	3	1	2	3
Sample weight of Crucible (a)	13.836	10.25	12.23	13.84	10.27	12.53
Sample weight of crucible and sample before drying (b)	18.83	15.25	17.27	18.84	15.27	17.62
Sample weight of crucible and sample after drying (C)	18.73	15.15	17.17	18.78	15.20	17.56

% of moisture content = $\frac{(b-c)}{(b-a)} \times 100$

5. **Density**

Table 5: Results of Density Determination

	TRADITIONAL			MECHANICAL		
	1	2	3	1	2	3
Weight of sample + bottle (S)	18.85	18.85	19.11	20.36	20.36	20.29
Weight of distilled water + bottle (D)	18.57	18.57	18.83	20.81	20.81	20.72

Weight of bottle (E) = 10g

Density $= \frac{S-E}{D-E}(g/cm^3)$

6. **Unsaponifiable Matter**

Table 6: Results of unsaponifiable value determination

	TRADITIONAL			MECHANICAL		
	1	2	3	1	2	3
Mass of residue (m_1)	0.43	0.42	0.43	0.42	0.42	0.42
Mass of residue obtained with blank (m_2)	.0014	0.0012	0.0014	0.0013	0.0013	0.0013
Mass of fatty acid (m_3)	0.42	0.40	0.42	0.41	0.41	0.41

Weight of the sample in g = 5.01g

Unsaponifiable matter is expressed as

$$= \frac{100(m_1 - m_2 - m_3)}{M_o}$$

Plate 1 Traditionally extracted palm oil

Plate 2 Mechanically extracted palm oil