

# Microflora and Physicochemical Composition of Edible Oil Sold in River State Nigeria

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**Abstract:** Edible oil is one of the most important and commonly used processed foods. The study was done to assess the microbial quality and physicochemical composition of edible oil sold in River state. A total of 50 samples were collected from the four locations in sterile bottles and analyzed for microbial quality and physicochemical compositions. The Free Fatty Acids, Peroxide Value, Iodine Value and PH Value were determined. The pH of the groundnut oil samples ranged from 5.29 to 6.92 the free fatty acid ranged from 1.93 to 3.26, the peroxide value ranged from 1.89 to 4.1, the iodine value ranged from 14.33 to 30.92 and the moisture content range from 0.02 to 0.12 . The pH of the palm oil samples were slight acidic ranging from 4.96 to 5.56, the free fatty acid ranged 1.55 to 2.07 for, the peroxide value ranged from 27.83 to 56.01, the iodine value ranged from 16.2 to 43.56 while the moisture content ranged from 0.73 to 1.74 .Most of the samples had highest value as compared to WHO standard. The Total Bacteria Count ranged from 2.9 (log<sub>10</sub>) for Refined Palm Oil sample to 5.1 (log<sub>10</sub>) for CP (Choba Palm Oil Sample). TBC of the groundnut oil sample ranged from 3.0 (log<sub>10</sub>) for REG (Refined Groundnut Oil Sample) to 5.3 (log<sub>10</sub>) for Choba sample (CG), the total fungal count (TFC) of the Palm Oil and groundnut oil samples respectively, the fungal count of the palm oil sample ranged from 4.2 (log<sub>10</sub>) for refined palm oil sample to 5.2 (log<sub>10</sub>) for CP (Choba Palm Oil Sample). The total fungal counts for the groundnut oil sample ranged from 4.0 (log<sub>10</sub>) for Refined groundnut oil (REG) samples to 5.3 (log<sub>10</sub>) For Mgbuoba ground nut oil sample (MG). Organisms isolated from the oil samples include; *Bacillus subtilis* (20%), *Micrococcus* sp. (15%), *Proteus* sp.(27%), *Staphylococcus aureus*,(59% and *Klebsiella* sp ,(30%) *Mucor* sp.(16%), *Aspergillus niger*, (55%), *Penicillium* sp ,(52%) and *Aspergillus flavus* ,(42%) .The microbial and physico-chemical quality of the edible oil is a clear indication of the poor hygienic practice and processing methods of edible oil

**Keywords:** Edible oil; Microbial Quality, Physicochemical Composition.

## 1. INTRODUCTION

Oils" is unified term for more or less viscous, generally organic chemical liquids<sup>1</sup>. Edible oil from plant sources is very vital in various food and application industries. They give characteristic flavours and textures to foods as essential diet components<sup>2</sup>. Vegetable oils has contributed to the diet in many countries, ensuring as a good source of protein, lipid and fatty acids for human dietetics including the repair of weary tissues, new cells formation as well as a useful source of energy<sup>3</sup>. Oil palm fruit is a monocotyledon grouped to the genus *Elaeis*. The African oil palm (*Elaeis guineensis*) is native to West Africa<sup>4</sup>. It is a tree crop and the largest oil producing plant. It produces two types of oils; these are palm kernel oil and palm oil. Palm oil is an edible vegetable oil extracted from the fruit of the palm oil tree (*Elaeis guineensis*). Palm oil which is orange-red to brownish or yellowish-red in color is extracted from the fleshy mesocarp of the fruit of oil palm tree. Palm oil itself is reddish because it contains high amount of beta-carotene<sup>5</sup>.

Groundnut (*Arachis hypogaea* Linn) on the other hand is a major annual oilseed crop and a good source of protein<sup>6</sup>. Groundnut is one of the most important cash crops of Nigeria. It is a low-priced commodity but an important source of all the nutrients. Groundnut is the sixth most important oilseed crop in the world. It made up of 48-50% of oil and 26-28% of protein, and is a rich source of dietary fiber, minerals, and vitamins. Groundnut oil is a vegetable oil which is made up of

only a small proportion of non-glyceride constituents. Its fatty acid composition is complex including saturated fatty acids covering a wide range of molecular weights. Groundnut oil is good food oil, with good flavor and high quality with its low free fatty acid value. The oil is commonly used as cooking oil and for the manufacturing of soap, margarine and cosmetics. Oils may go rancid and produce an unpleasant odour and flavour if not handled and stored properly. The main factors that cause rancidity (in addition to moisture and enzymes) are bacteria light, heat and air <sup>7</sup>

Oil is the most common health risk. This problem is repeatedly observed in many edible oil market areas. Food handlers with poor personal hygiene and inadequate knowledge on food safety and quality could be the source of food pathogen. The presence of Microorganisms is known to cause chemical changes in edible oil that can cause deterioration in the quality of the oil <sup>8</sup>. The lipolytic activity of fungi on the triglycerides of oils and fats used in baking formulations may cause rancidity, acidity, bitterness, soapiness and other off flavors. Such activities may occur in seeds or other plant parts from which oils are obtained. There are various brands of vegetable oils sold in the markets located in Nigeria. Some are produced in the country while some are imported. Palm oil and groundnut can be refined industrially to give a light-colored product which can be used for other confectioneries<sup>9</sup>. Traditional methods of production are employed for the extraction of edible oil by individuals who have little or no knowledge neither of modern aseptic production techniques nor of the microbiological implication of poor sanitation and storage methods. Also, different local oil market sites where oil is been sold are mostly overcrowded and in poor sanitary condition and the oil sellers use unhygienic oil containers and measurement jugs to dispense oil to consumers therefore, edible oil is prone to contamination by microorganisms found in the environment. Raw materials and equipment used for the processing and for storage and distribution also causes microbial contamination <sup>10</sup>.

In the light of the possible consequences of consuming unhealthy edible oils, this study is being undertaken, so as to access the quality of oils commonly sold in the markets, if they are good for consumption, through examination of their microbial load. Some branded and unbranded Palm and Groundnut oil sold for consumption contain microorganisms such as *Staphylococcus aureus*, *Bacillus subtilis*, amongst others. These organisms are capable of causing mild to chronic diseases.

Palm oil, obtained from a tropical plant, *Elaeis guineensis*. The genus *Elaeis* comprises two species, namely *E. guineensis* and *E. oleifera*. Palm oil is a lipid extracted from the fleshy orange-red mesocarp of the fruits of the oil palm tree. Palm oil is an important and versatile raw material for both food and non-food industries. Of recently, palm oil has become the second most consumed oil all over the world with a competitive price compared to other edible oils <sup>11</sup>. Palm oil is one of the major oils and fats produced and traded in the world today. Within the span of four decades, palm oil has emerged as the fastest growing oil in the world. In fact, palm oil is projected to be the world's largest oil produced, although it is currently occupying second position after soybean oil <sup>12</sup>. Groundnut has been reported that South America was the place from where cultivation of groundnut originated and spread to Brazil, Southern Bolivia and North-western Argentina. Groundnut was introduced by the Portuguese from Brazil to West Africa and then to southwestern India in the 16th century. Almost every part of groundnut is of commercial value.

The groundnut oil has different uses but it is mainly used as cooking oil. It is used in many products like soap making, fuel, cosmetics, shaving cream, leather dressings, furniture cream, lubricants, etc. Groundnut oil is also used in making vanaspati ghee and in fatty acids manufacturing. It is also used as a medium of preservation for preparation of pickles, chutney, etc. The groundnut oil is used in making different types of medicated ointments, plasters, syrups and medicated emulsion. It is also used to make various food preparations like butter, milk, candy and chocolate, chutney, groundnut pack, laddu, barfi (chukii), etc. Groundnut oil is of high quality and can withstand higher temperatures without burning or breaking down. It has neutral flavour and odour. It does not absorb odour from other foods <sup>13</sup> The aim of this study is to assess the sanitary quality of branded and unbranded Palm and Groundnut oil sold in four different market

## 2. MATERIALS AND METHODS

### Collection of Samples

Samples of palm oil and groundnut oil and were collected from four different locations in Port Harcourt metropolis.

A total number of two (2) branded and 48 unbranded palm oil and groundnut oil samples were collected from FOUR (4) LOCATIONS (Choba, Alakahia, Rumuosi, Mgbuoba). The samples were then transported to the laboratory for microbiological and physicochemical analysis.

### Isolation of Microorganism

#### Total Bacteria Count

Ten ml of the vegetable oils and palm oil was weighed using analytical balance and homogenized with 90 ml of sterile Tween 80 to obtain a stock solution. Thereafter serial dilution was carried out up to  $10^{-3}$  dilution. One milliliter of the appropriate dilution was pour plated in nutrient agar plates. The nutrient agar plates were incubated at  $37^{\circ}\text{C}$  for 24-48 hours. After incubation the number of discrete colonies were counted and recorded in cfu/ml.

#### Total Fungal Count

Likewise, ten ml of the vegetable oils and palm oil was also weighed using analytical balance and homogenized with 90 ml of sterile Tween 80 to obtain a stock solution. Three-fold serial dilution was carried out up to  $10^{-3}$  dilution. One milliliter of the appropriate dilution was pour plated in potato dextrose agar plates. The potato dextrose agar plates were then incubated at room temperature for 72 hrs. After incubation the number of discrete colonies were counted and recorded in cfu/ml.

**Characterization and identification of bacterial and fungal isolates:** All bacterial isolates were characterized and identified based on their cultural, morphological, and biochemical characteristics as described by<sup>14</sup> All fungal isolates were identified based on their macroscopic and microscopic appearance with reference to manual of<sup>16, 15</sup>.

#### PHYSICO-CHEMICAL ANALYSIS OF SAMPLES:

Peroxide value, Iodine value, relative density Free-fatty acid and pH of each sample was analyzed using methods employed by<sup>17 18 19</sup>.

#### Determination of pH

The pH of the oil samples was determined with a pH meter. About 30 cm<sup>3</sup> of the oil sample was measured into a beaker, then the pH meter electrode was immersed into the beaker containing the oil sample and the pH value was recorded digitally. Babatunde, and , Bello 2016)

#### Determination of moisture content

The moisture content of the oil samples were determined by using the British Standard Method.(Babatunde, and , Bello 2016)

### 3. RESULTS

Figure 1 shows the total bacterial counts (TBC) of the palm oil sample collected from the markets. The TBC ranged from 2.9 ( $\log_{10}$ ) for Refined Palm Oil sample to 5.1 ( $\log_{10}$ ) for CP (Choba Palm Oil Sample). Figure 2 showed the TBC of the groundnut oil sample ranging from 3.0 ( $\log_{10}$ ) for REG (Refined Groundnut Oil Sample) to 5.3 ( $\log_{10}$ ) for Choba sample (CG). Figure 3 and 4 shows the total fungal count (TFC) of the Palm Oil and groundnut oil samples respectively. From the results in figure 3, the fungal count of the palm oil sample ranged from 4.2 ( $\log_{10}$ ) for refined palm oil sample to 5.2 ( $\log_{10}$ ) for CP (Choba Palm Oil Sample). The total fungal counts for the groundnut oil sample ranged from 4.0 ( $\log_{10}$ ) for Refined groundnut oil (REG) samples to 5.3 ( $\log_{10}$ ) For Mgbuoba ground nut oil sample (MG). Organisms isolated from the oil samples include; *Bacillus subtilis* (20%), *Micrococcus* sp. (15%), *Proteus* sp.(27%), *Staphylococcus aureus*, (59% and *Klebsiella* sp ,(30%) *Mucor* sp.(16%), *Aspergillus niger*, (55%), *Penicillium* sp ,(52%) and *Aspergillus flavus* ,(42%) was the fungi organisms isolated from the oil samples Table 1 and 2 below shows the percentage occurrence of isolated microbes. Table 3 And 4 Shows the physicochemical parameters of the palm oil and groundnut oil samples respectively. The analyzed parameters include, pH, free fatty acid, peroxide value, iodine value and moisture content. The pH of the groundnut oil samples ranged from 5.29 to 6.92 for CG and MG, the free fatty acid ranged from 1.93 to 3.26 for CG and REG, the peroxide value ranged from 1.89 to 4.1 for RG, the iodine value ranged from 14.33 to 30.92 respectively and the moisture content range from 0.02 to 0.12 for AG and RG respectively

Results

Table 1: Percentage occurrence of the bacteria isolates

Microbes isolated/ Sample codes	<i>Bacillus subtilis</i>	<i>Micrococcus sp.</i>	<i>Proteus sp.</i>	<i>Staphylococcus aureus</i>	<i>Klebsiella sp.</i>
AO	2(20%)	1 (10%)	1 (10%)	5 (50%)	3(30%)
RO	1(7%)	1 (15%)	4 (26%)	8 (53%)	2 (13%)
CO	5(13%)	2 (9%)	3(13%)	11 (50%)	6 (27%)
MO	3(18%)	5 (10%)	6 (27%)	13 (59%)	1 (5%)

Keys: AO- Alakahia Oil RO- Rumuosi Oil CO- Choba Oil MO- Mgbuoba t Oil

Table 2: Percentage Occurrence of the Fungi Isolates

Microbes isolated/ Sample Codes	<i>Mucor sp.</i>	<i>Aspergillus niger</i>	<i>Penicillium sp.</i>	<i>Aspergillus flavus</i>
AO	1 (4%)	11 (39%)	7 (29%)	5 (20%)
RO	Nil	15 (55%)	4 (15%)	8 (29%)
CO	2 (10%)	8 (28%)	11(52%)	Nil
MO	3(16%)	5((28%)	3(16%)	8*42%)

Keys: AO- Alakahia Oil RO- Rumuosi Oil CO- Choba Oil MO- Mgbuoba t Oil

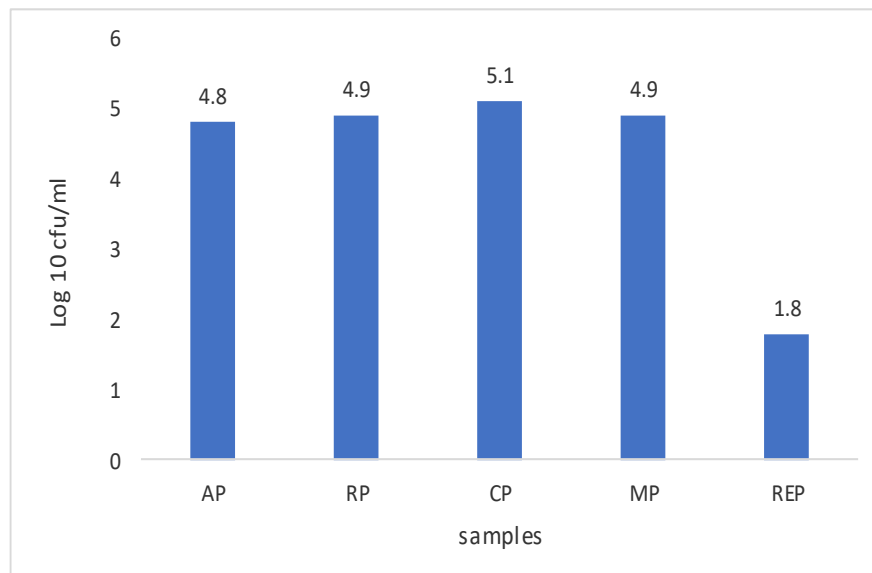
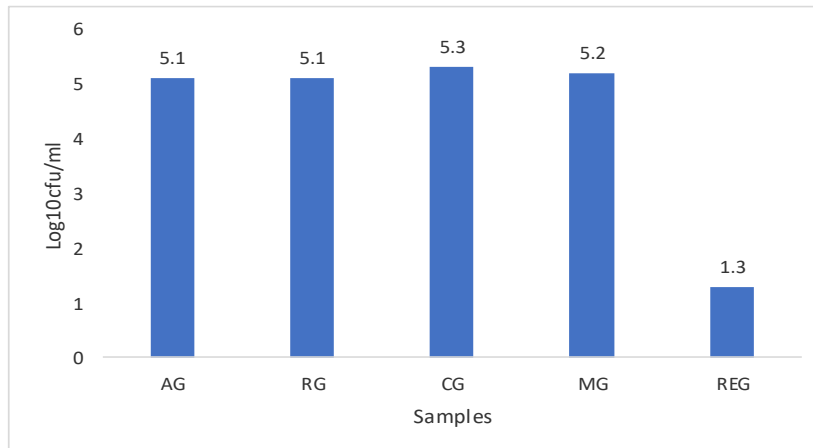


Figure 1: Mean Total Bacteria Count of Palm oil

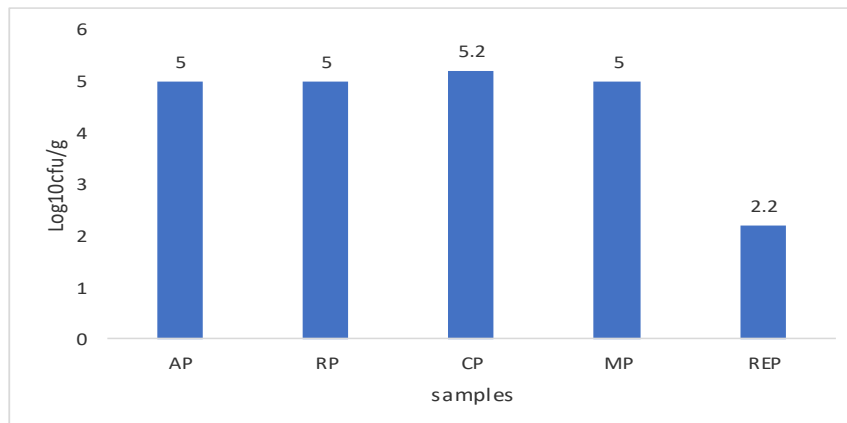
AG- Alakahia Palm Oil RG- Palm Oil CG- Choba Palm Oil

MG- Mgbuoba t Palm Oil REG – Refined Rumuosi Palm Oil (kings oil)



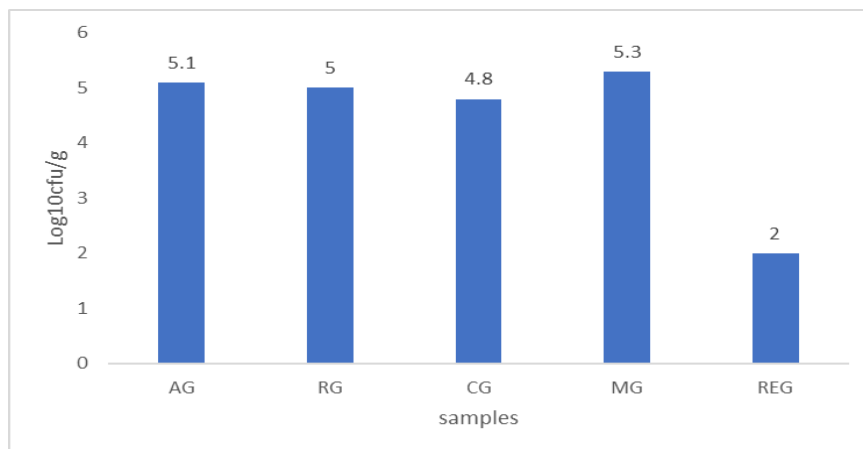
**Figure 2: Mean Total Bacteria Count of Groundnut oil samples**

**AG-** Alakahia Groundnut Oil **RG-** Groundnut Oil **CG-** Choba Groundnut Oil  
**MG-** Mgbuoba Groundnut Oil **REG** – Refined Rumuosi Groundnut Oil (kings oil)



**Figure .3: Mean Total Fungal Count of Palm Oil Samples**

**AG-** Alakahia Palm Oil **RG-** Palm Oil **CG-** Choba Palm Oil  
**MG-** Mgbuoba t Palm Oil **REG** – Refined Rumuosi Palm Oil (kings oil)



**Figure .4: Mean Total Fungal Count of Groundnut Oil samples**

**AG-** Alakahia Groundnut Oil **RG-** Groundnut Oil **CG-** Choba Groundnut Oil  
**MG-** Mgbuoba Groundnut Oil **REG** – Refined Rumuosi Groundnut Oil (kings oil)

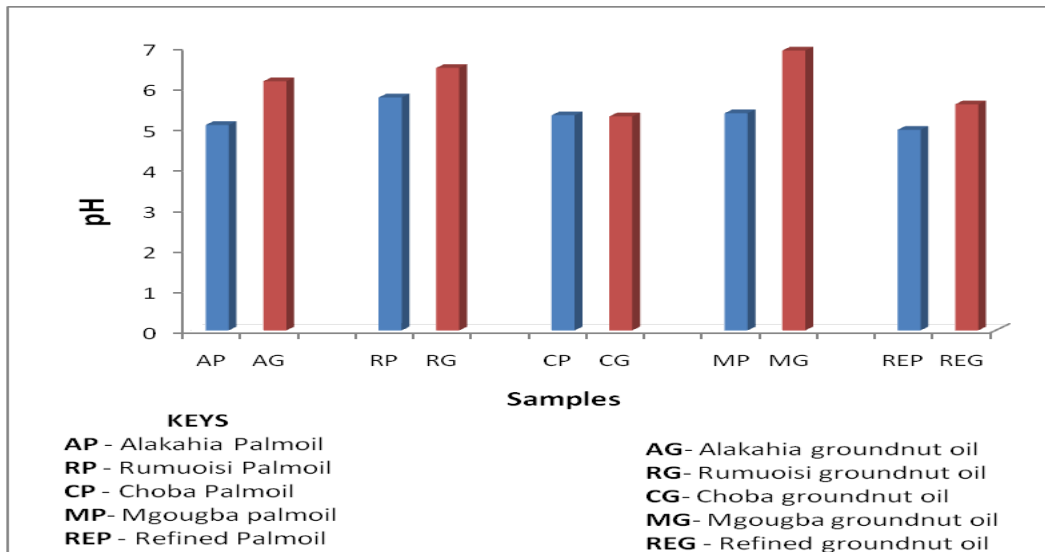


Figure 5: Mean pH of the various edible oil from the different markets

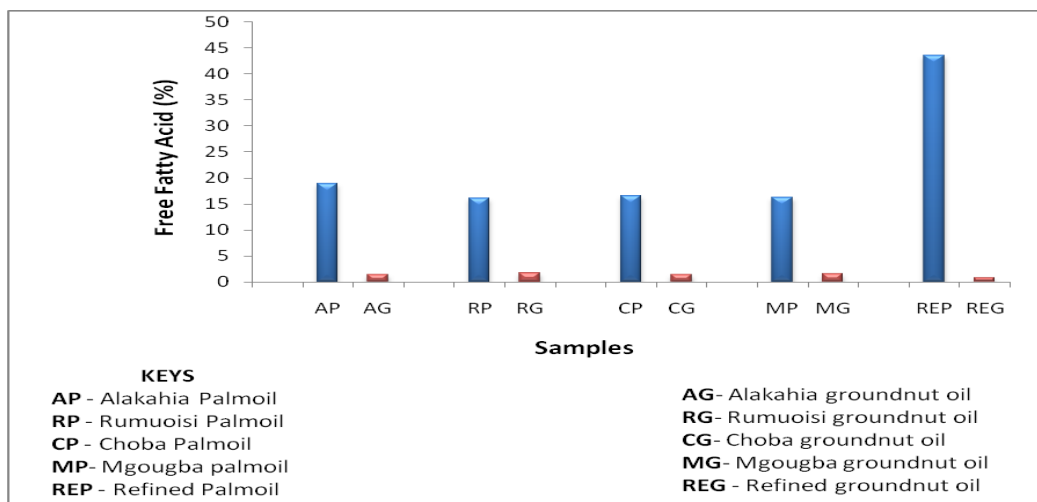


Figure 6: Mean Fatty Acid of various edible oil from different markets

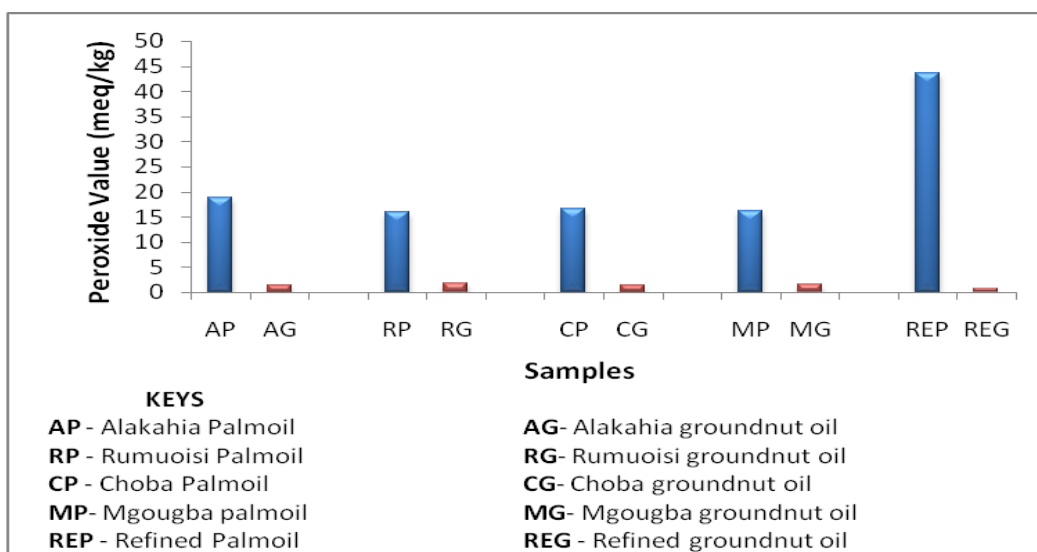


Figure 7: Mean Peroxide Value of the edible oil from different markets

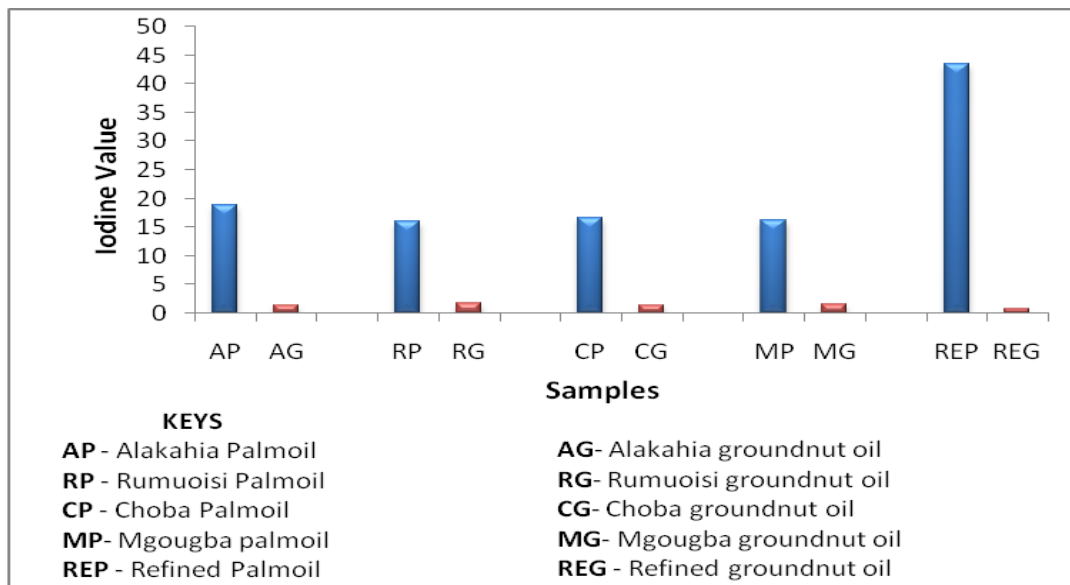


Figure 8: Iodine Value of various edible oil from the different markets.

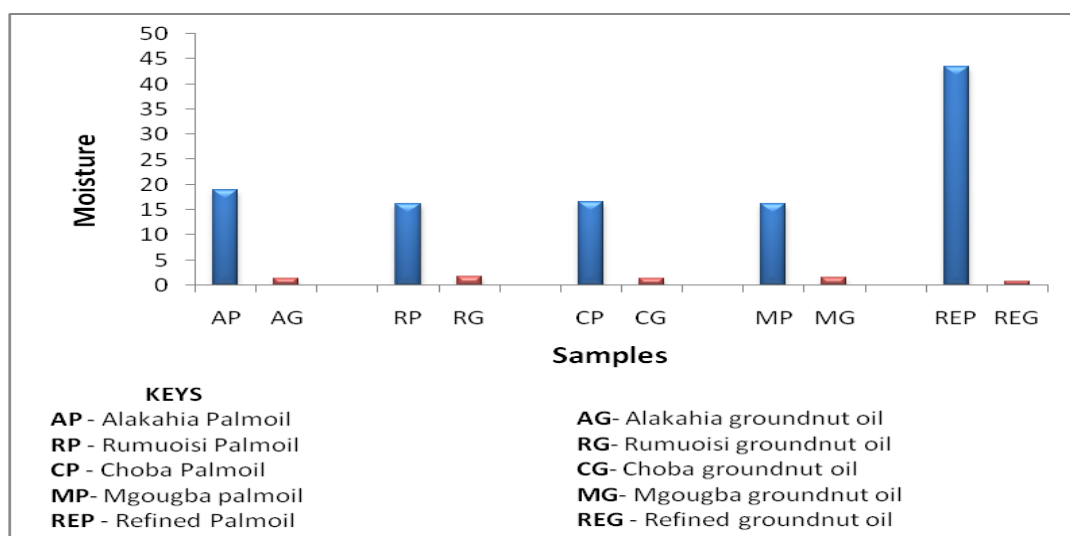


Figure .9: Mean Moisture Content of the various edible oil from different markets.

#### 4. DISCUSSION

The quality of palm kernel oil (PKO) depends on its physicochemical and microbiological quality. As shown in the results, the TBC ranged from 1.8 ( $\log_{10}$ ) for Refined Palm Oil sample to 5.1 ( $\log_{10}$ ) for CP (Choba Palm Oil Sample). While the TBC of the groundnut oil sample ranged from 3.0 ( $\log_{10}$ ) for REG (Refined Groundnut Oil Sample) to 1.3 ( $\log_{10}$ ) for Choba sample (CG). Likewise, the total fungal count (TFC) of the palm oil sample ranged from 2.2 ( $\log_{10}$ ) for refined palm oil sample to 3.2 ( $\log_{10}$ ) for CP (Choba Palm Oil Sample) and the total fungal counts for the groundnut oil sample ranged from 2.0 ( $\log_{10}$ ) for Refined groundnut oil (REG) samples to 5.3 ( $\log_{10}$ ) for Mgbuoba groundnut oil sample (MG).

The microbial load of the palm and groundnut oil samples obtained from the four (4) locations where higher than the minimum acceptable microbiological level except for Mgbuoba palm oil with 4.9  $\log_{10}$  (MP), Refined groundnut oil 1.3  $\log_{10}$  (REG), and palm oil with 1.8  $\log_{10}$  (REP), Alakahia palm oil with 4.8  $\log_{10}$  (AP) and Rumuoisi palm oil with 4.9  $\log_{10}$  (RP), which fall within the microbial value of  $10^4$  /ml. stipulated by the Nigerian Agency for Food and Drug Administration (NAFDAC),<sup>10</sup>. The results showed that refined palm oil and groundnut oil sample had less bacterial and fungal count compared to the other samples collected from the markets.



Some bacteria and fungi thrive in vegetable oils by production of enzyme lipase and spores and their ability to produce spores has aided these microbes to survive the anaerobic nature of edible oil and makes them resistant to heat. The organisms isolated from the oil samples include; *Bacillus subtilis*, (20%) *Micrococcus* sp.(15%), *Proteus* sp.(27%) *Staphylococcus aureus*(59%) and *Klebsiella* sp.(30%) *Mucor* sp.(16%) *Aspergillus niger*.(55%) *Penicillium* sp.(52%) and *Aspergillus flavus*(42%). This result is in agreement with the findings of <sup>20,21</sup> who isolated similar bacteria and fungi from vegetable oil sold in Jos and Port harcourt markets. From their study, they isolated *Enterobacter* sp, *Bacillus* sp, *Proteus* sp, *Micrococcus* sp, *Staphylococcus aureus*, *Aspergillus Niger*, *Aspergillus flavus*, *Aspergillus fumigatus*, *Candida* sp, *Mucor* sp, and *Penicillium* sp.

*Staphylococcus aureus* has the highest percentage occurrence with *Micrococcus* sp. and *Bacillus subtilis* also frequently isolated. The detection of these microbes in the oil samples indicated their lipolytic activity which could lead to the deterioration of the vegetable oil samples. The pH of the palm oil samples was slight acidic ranging from 4.96 to 5.56 for REP and AP, the free fatty acid ranged 1.55 to 2.07 for MP and REP, the peroxide value ranged from 27.83 to 56.01 for REP and AP, the iodine value ranged from 16.2 to 43.56 for MP and REP while the moisture content ranged from 0.73 to 1.74 for REP and RP respectively.

The liberation of free fatty acids is an indication of spoilage. According to the Food and Agricultural organization (FAO) and World health organization (WHO) stipulate the acceptable free fatty acid value (FFA) not to exceed 1.376%. Most of the samples were higher than the acceptable standard except for samples from refined palm and groundnut oil samples. The high FFA values of the oil samples obtained could be due to the high number of lipid utilizing microbes isolated from the sample from these markets this report in is agreement with <sup>21</sup> who reported high FFA values from palm oil samples sold in Port Harcourt metropolis The values of the free fatty acid obtained in this study can also be compared to that of <sup>22</sup>.

The slightly low moisture content may be attributed to the fact that most of the palm and groundnut oil sold at the market are produced through local processes, so there could have been accidental wetting or poor handling of the oil leading to an increased moisture content, although the refined product was lower compared to the unrefined oil samples. The high moisture content could also have been due to the fact that the production of the unrefined oil is subjected to improper boiling (boiling is known to reduce moisture content).<sup>1,10</sup>

Peroxide value, reflects the state of oxidation and therefore the stability and quality.<sup>17</sup> indicated that high peroxide value above 14mEq/kg is an indication of the degree of rancidity which increases spoilage of edible oil. The peroxide value observed in the study could have been as a result of increased moisture of the oil millers. Previous study has demonstrated that oil acidification and peroxidation processes are significantly enhanced by high moisture content <sup>4</sup>. This result is in agreement with <sup>20,21</sup> who reported high peroxide value in palm oil sold in Jos urban markets. The iodine value showed that the groundnut oil iodine sample were higher than the palm oil iodine sample. Iodine number measures the degree of unsaturation of free fatty acids indicating that the higher the degree the greater the likely-hood of rancidity. According to the FAO/WHO and CODEX standards, the limits value for iodine number in grams is 50.0-55.0 in edible oil. In relation to the microbial standard grade of vegetable oil permissible in Nigeria postulated by NAFDAC. The high microbial load observed in some of the oil samples as well as the presence of lipolytic microbes in the vegetable oils collected from the markets may be due to the local method of processing, handling of the oil, the mechanism of storage and the hygienic processing technique during milling, processing, transportation and even the environment. Good manufacturing practice could reduce the potential of contamination by these microbes. From the result obtained in this study, the refined product of both palm and groundnut oil samples were of better quality than the locally refined product. Most vegetable oil distributed are produced by traditional extractors, according to <sup>4</sup>. It has been demonstrated that oil produced by traditional oil extraction methods are of lesser quality when compared with oil produced from industrial oil mills. The high counts obtained from the oil sample purchased from these markets indicates the poor processing and poor handling of palm oil by extractors and local sellers. Improvement in the production procedures and processes as well as good seed selection, good handling practices and clean environment can go as far improving the standard of these vegetable oils.

## 5. CONCLUSION

The microbial and physico-chemical quality of the edible oil is a clear indication of the poor hygienic practice and processing methods of edible oil The iodine value of the oils indicates that the oils are non drying oil of low unsaturation. It shows also that the oils are slow to oxidation, will remain liquid form for a long period and may not induce high blood



pressure disease. The peroxide values of the vegetable oils shows that the oils contain low molecular weight fatty acids of low unsaturation, and this implies that the oils suitable for consumption, free fatty acid is an important qualitative parameter, since fats and oils contain some level of free fatty acid there will always be an increase in acidity with time during transportation and storage.

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