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# Assessment of Palm Oil Sold in Mainland Markets, Lagos State, Nigeria

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## Abstract

The provision of safe, nutritious and healthy foods forms part of the focus for Sustainable Development Goal worldwide. This study examined the quality of palm oil obtained from major markets in Mainland Area, Lagos State, Nigeria. Two hundred samples (one hundred samples per batch) used for this research work were obtained in the month of January (1st batch) and June (2nd batch). Eight of these samples were selected and were analysed. The physicochemical properties of the samples which include melting point, flash point, moisture content, free fatty acids (FFA), iodine value (IV), peroxide value (PV), saponification value (SV) were analysed during the period under study. The results obtained showed that saponification value (SV), iodine value, peroxide value and free fatty acid ranged between 157.20 - 212.84 mg/KOH/g, 84.94 - 179.71 Wij's, 7.15 - 10.35 meq/kg and 14.70 -21.45 mg/KOH/g respectively. Melting point and flash point ranged from 33.40 - 35.00°C and 232.00 - 232.60°C respectively while moisture content ranged from 0.38 - 2.48% and pH ranged from 7.00 - 7.85. The results obtained showed that there is need for improved processing technique, good handling/storage practices as well as public enlightenment to ensure that high quality palm oil are sold in the markets.

***Keywords:*** *Quality; Palm Oil; Physiochemical; Melting Point; Moisture*

## Introduction

Oil palm (*Elaesis guineensis Jacq*.) is a major food crop whose demand has increased considerably for some years now. This is due in part to shift in consumption pattern from animal fat to easily digestible vegetable oil as well as potential profitability and diversification of crops. For this reason, the demand for palm oil is bound to increase greatly [1]. Oil palm (*Elaesis guineensis*) belongs to the Palmae family and indigenous to West Africa [2]. Research has shown that it is the most productive and economic oil crop in the world in which an hectare plantation will produce about 10 to 35 tonnes of fresh fruit bunch (FFB) per year [3-5]. Adebowale [6] has shown the possibility of producing 7,250 liters/hectare/yr of palm oil from high oil yield of palm tree.

Crude palm oil has been found to be the richest natural source of carotenoid which is about 15 times more than that of carrot. Carotenoids are vitamin A precursors that can be converted into vitamin A when it is absorbed by human body. It improves immune and cardiovascular functions via diverse mechanisms as well as acting as biological antioxidant, protecting the cells and tissue from damaging effect of free radicals which can lead to degenerative diseases such as heart disease and cancer, as well as general ageing [4,5].

Red palm oil is a deacidified and deodorized oil that retains 80% of the original carotenoids, making it a remarkable source of vitamin A. These natural antioxidants act as buffers against free radicals that are responsible for cellular ageing, atherosclerosis, cancer, arthritis, and Alzheimer's disease [7].

Palm oil (PO), a vegetable oil obtained from the fruit of the palm tree (*Elaesis guineensis*) is composed of 50% palmitic acid, 40% oleic acid and 10% linoleic acid. It has about half of its fatty acid content made up of saturated fatty acids [8], a condition that is rare among vegetable oils [9].

In addition, saturated fats are those whose chains are saturated with hydrogen and palm oil is an example of these and high intake of saturates have been linked with coronary heart disease [10]. Palm oil has been shown to consist of 50% short chain saturated fatty acids, 40% monounsaturated fatty (MUFA) and 10% polyunsaturated fatty acid (PUFA). These values are lower compared with the 90% saturated fatty acid and 9% unsaturated fatty acids in coconut oil. The saturated fatty acids in palm oil are made up of trace amount of lauric and myristic acids and large amount of palmitic acid (44%). The initial two have the potential of increasing the low density lipoprotein as well as cholesterol concentration. Chong [11] has shown that palm oil contains about 600 - 700 ppm cholesterol but the *cis*-double bonds present in palm oil can be altered to form *trans*-configuration when directly used by food industries even without hydrogenation [12,13].

Wattanapenpoiboon and Wahlqvist [12] have also shown that palm oil has α, β and γ carotenes which are precursor of vitamin A. Finally, Kabara [14] has proven that how long it takes for fat to be digested and absorbed is a function of the chain length of the fatty acids.

This research was carried out to assess the quality of palm oil sold in Mainland market of Lagos, Nigeria.

## Materials and Methods

Two hundred samples (one hundred samples per batch) used for this research work were purchased from major markets in Mainland area of Lagos State between the month of January (1st batch) and June (2nd batch) out of which 8 samples were randomly selected for this study while the analysis were carried out in the laboratories of Department of Food Technology, Yaba College of Technology, Lagos, Nigeria.

### Determination of free fatty acid (FFA)

The FFA concentration was determined using the method of Aletor., *et al.* [15] which involves titrating the alcoholic solution of the oils with an aqueous solution of sodium hydroxide using phenolphthalein as indicator. About 10g of the oil was weighed into the conical flask. Fifty ml of alcoholic ether mixture in equal volume was added and it was warmed in an oven to obtain a homogeneous mixture. One (1 ml) of phenolphthalein indicator was added and titrated with 0.1M NaOH until a fairly pink end point was obtained. This procedure was repeated for all the samples

$$\% \text{ FFA as palmitic acid} = \frac{\text{ml of NaOH x Molarity x 28.2 mg}}{\text{Weight of sample}}$$

### Determination of peroxide value

About 5g sample was put inside 250 ml Erlenmeyer and 30 ml acetate acid was added. This was shaken for proper mixing of the blends after which 0.5 ml potassium iodide was added. This was allowed to rest for 1 minute and shaken once a while followed by the addition of 30 mL distilled water. After which the mixture was titrated with 0.1N $Na_2S_2O_3$ until the yellow colour disappeared. Starch solution was used as indicator for this reaction. Peroxide value was recorded in ml -equivalent from peroxide in every 1000g [16].

$$\text{Peroxide value} = \frac{(\text{mL}Na_2S_2O_3 \text{ x Normality } Na_2S_2O_3 \text{ x } 1000)}{\text{Weight samples}}$$

### Iodine value determination

The iodine value was determined by the Wijs' method using the guide provided by Pike [17] as described by Akinola., *et al* [18]. A moderate mixture of iodine monochloride and acetic acid were added to the palm oil samples in conical flasks. The mixture was allowed to stand for 30 minutes in dark. About 15 ml of 10% potassium iodide was added to each mixture. The solution was titrated with 0.1 ml sodium thiosulphate solution using starch indicator to a colourless end point (S). Analysis of blank (B) was also carried out.

$$\text{Therefore; Iodine value} = \frac{(B - S) \times N \times 12.69}{\text{Sample weight (g)}}$$

Where;

B = blank titre value; S = sample titre value; N = normality of $Na_2S_2O_3$; 12.69 was used to convert from meq thiosulphate to g iodine; molecular weight of iodine = 126.9.

### Saponification value determination

The saponification value was determined using the guide provided by Pike [17] as described by Akinola., *et al* [18]. About 2g of palm oil was weighed into excess 0.5M alcoholic KOH of about 25 ml in conical flasks. Heat was applied while swirling to saponify the fat. The treated palm oil samples were titrated with 0.5M HCl using 1% phenolphthalein as indicator. A blank titration was also carried out. The weight of sample and titration values of the blank and samples were calculated as:

$$\text{Saponification value} = \frac{(S - B) \times N \times 56.1}{\text{Sample weight (g)}}$$

Where,

S = Sample titrated, B =Blank titration, N = Normal titration of the HCl, 56.1 = The Molar weight of KOH.

### Determination of moisture content

Moisture content was determined by the oven dry method using the procedures of the AOAC [19]. Five (5g) gram of palm oil was poured into previously weighed moisture dishes. Each sample was analysed in triplicate. They were then introduced into Gallen Kamp oven (BS Model OV-160) and were maintained at 63 ± 2°C until constant weight was attained, with the drying period showing additional loss of ≤ 0.05. The moisture dishes were cooled in a desiccator and the difference in weight was obtained which was used to calculate the % moisture content.

$$\text{Percentage moisture content (\%)} = \frac{B\text{-}C}{A}$$

A = Sample weight in (g)

B = Weight of dish + sample weight before drying

C = Weight of dish + sample weight after drying

B - C = Weight loss after drying (moisture content of sample).

### pH value determination

This was determined using the pH meter.

### Mould and yeast test

Ten (10g) grams of Potato Dextrose Agar was weighed and dissolved in 250 ml of distilled water, after which it was brought to boiling for some minutes before transferring into the autoclave for sterilization which was done at 121°C for 15 minutes. Ten test tubes were

used for this determination and were also sterilized in the autoclave, after which 9 ml of distilled water was put into each of them. After 15 minutes, the agar and all the test tubes was brought out and cooled. One (1) ml of each sample was transferred to each test tube for serial dilution while $10^3$ was used for the determination of mould and yeast. After serial dilution 1ml of each sample was poured into the petri dishes containing Potato Dextrose agar. This was allowed to solidify. All the plates was inverted and incubated at room temperature for three to four days [20].

## Results and Discussions

| Samples | Free fatty Acid (%) | Saponification value (mg/KOH/g) | Iodine value (Wij's) | Peroxide value (meg/kg) | Moisture content (%) | P$^H$ Value |
|---|---|---|---|---|---|---|
| KLM | 17.19 ± 0.52$^{ab}$ | 157.20 ± 0.17$^{c}$ | 105.07 ± 0.44$^{c}$ | 9.60 ± 0.14$^{b}$ | 0.49 ± 0.01$^{ab}$ | 7.20 ± 0.00$^{c}$ |
| KLQ | 21.45 ± 1.15$^{b}$ | 193.66 ± 1.82$^{b}$ | 84.94 ± 1.12$^{e}$ | 10.35 ± 0.35$^{d}$ | 0.5 ± 0.00$^{bc}$ | 7.85 ± 0.07$^{a}$ |
| QRL | 20.95 ± 0.15$^{b}$ | 209.06 ± 0.13$^{a}$ | 86.51 ± 1.10$^{e}$ | 9.95 ± 0.21$^{b}$ | 0.38 ± 0.01$^{a}$ | 7.00 ± 0.00$^{d}$ |
| QVI | 20.11 ± 1.46$^{b}$ | 212.84 ± 0.49$^{a}$ | 143.57 ± 1.00$^{b}$ | 8.45 ± 0.21$^{c}$ | 0.6$^{d}$ ± 0.02$^{d}$ | 7.50 ± 0.00$^{b}$ |
| ORL | 18.50 ± 0.80$^{ab}$ | 191.96 ± 0.25$^{b}$ | 99.82 ± 1.97$^{d}$ | 9.65 ± 0.07$^{b}$ | 0.61 ± 0.01$^{cd}$ | 7.55 ± 0.07$^{b}$ |
| OML | 14.70 ± 0.40$^{a}$ | 209.35 ± 0.54$^{a}$ | 179.71 ± 1.80$^{a}$ | 7.15 ± 0.07$^{d}$ | 0.99 ± 0.01$^{e}$ | 7.30 ± 0.00$^{c}$ |
| ZYE | 15.58 ± 0.32$^{a}$ | 197.99 ± 0.34$^{b}$ | 101.72 ± 0.17$^{c}$ | 9.70 ± 0.14$^{b}$ | 0.51 ± 0.01$^{bc}$ | 7.00 ± 0.00$^{c}$ |
| ZUP | 18.05 ± 0.05$^{ab}$ | 192.51 ± 0.06$^{b}$ | 103.95 ± 1.17$^{c}$ | 9.45 ± 0.07$^{b}$ | 2.48 ± 0.06$^{f}$ | 7.25 ± 0.07$^{c}$ |

***Table 1:*** *Physicochemical properties of palm oil samples.*

*Values are expressed as Mean ± SD from duplicate samples, different letters within the same column are significantly different ($p < 0.05$).*

From table 1 above, the results obtained for free fatty acids (FFA) were above the acceptable limit. The maximum acceptable limit for free fatty acids (FFA) is 5% [3,21]. The free fatty acid obtained in this study ranged from 14.70 - 21.45 mg KOH/g. The high values obtained may be due to poor handling and display pattern prevalence in the market [22].

Saponification value is an indication of the molecular weight of triglycerides of oil. High saponification value, indicates high proportion of low fatty acid since this is inversely proportional to the average molecular weight or length of fatty acids. This means that the shorter the average chain length ($C_4$ - $C_{12}$), the higher the saponification value [23]. The value obtained for experimental samples ranged between 157.20 - 212.84 mg/KOH/g (Table 1) and are comparable with the recommended values of 195 - 205 mg/KOH/g for palm oil [24].

Iodine value gives an indication of the level of unsaturation in the samples which is valuable for detecting adulteration in vegetable oils [25]. The values obtained ranged between 84.94 - 179.71 Wij's. The results were comparable with those obtained by Orji and Mbata [26] but higher than SON/NIS standard of 45 - 53 Wij's. The high values showed that deterioration has commenced in the samples. Meanwhile, Ekwenye [22] has reported that high iodine value is an indication of greater degree of unsaturated fatty acid and higher tendency of rancidity.

Peroxide Value (PV) determines the degree of oil oxidation. It is the measure of freshness of the lipid matrix and oxidation particularly at primary stage when the oil is stored. This is as a result of the activities of lipolytic enzymes such as peroxidase and lipoxygenase [27]. The peroxide value obtained from this study as shown in table 1 ranged between 7.15 and 10.35 meq/k which is comparable with the standard value of 10 meq/kg [24].

The moisture content of any food is an index of its water activity ($a_w$) [28] which is an important quality. The moisture content obtained from this study ranged from 0.38 - 2.48%, which is higher than recommended standard of 0.29% [24]. This value has been shown to be

unacceptable for freshly produced palm oil, but accepted for palm oil meant for storage as documented by the Nigerian Stored Products Research Institute (NSPRI). The maximum safe moisture level for palm oil storage is 1%. Meanwhile, this result is in agreement with the findings of Okechalu., *et al* [25].

The pH of the experimental samples was generally neutral and differs from the findings of Ezediokpu., *et al.* [29] who recorded acidic pH in his study.

The melting point obtained from this study ranged between 33.40 - 35.00°C (Table 2). The melting points are within the 27 - 50°C as

| Sample | Melting point ($^0$C) | Flash point ($^0$C) | Smoke point ($^0$C) |
|---|---|---|---|
| KLQ | 33.45 ± 0.05$^a$ | 232.00 ± 0.00$^a$ | 232.05 ± 0.05$^{ab}$ |
| KLM | 35.00 ± 0.00$^d$ | 232.15 ± 0.05$^a$ | 232.10 ± 0.00$^a$ |
| QVI | 34.30 ± 0.00$^c$ | 232.00 ± 0.00$^a$ | 232.00 ± 0.00$^b$ |
| QRL | 34.45 ± 0.05$^c$ | 232.60 ± 0.60$^a$ | 232.00 ± 0.00$^b$ |
| OML | 34.40 ± 0.00$^c$ | 232.50 ± 0.50$^a$ | 232.00 ± 0.00$^b$ |
| ORL | 33.40 ± 0.00$^a$ | 232.10 ± 0.10$^a$ | 232.00 ± 0.00$^b$ |
| ZYE | 34.05 ± 0.05$^b$ | 232.00 ± 0.00$^a$ | 232.00 ± 0.00$^b$ |
| ZUP | 34.35 ± 0.05$^c$ | 232.00 ± 0.00$^a$ | 232.00 ± 0.00$^b$ |

***Table 2:*** *Physical properties of palm oil samples.*

*Mean values with different superscripts in the same column are significantly different ($p < 0.05$) at 95% confidence interval.*

recommended by (SON, 2000). Thus, these palm oil samples will remain liquid at room temperature.

High flash point is an indication of the quality of the palm oil for frying. This is between 232.00 - 232.60°C while the smoke point also ranged from 232.00 - 232.10°C.

The results showed that QVI, QRL, OML, OML, ZYE are not significantly different from each other while sample KLM and KLQ differs from each other.

The total viable count is represented in table 3. The highest and the lowest number of microorganisms were found in samples OML and QVI respectively. The presence of microbial hazards may be due to improper processing, poor handling and cross contamination resulting from display pattern in the market. The possible microorganisms isolated could be *Aspergillus flavus, Aspergillus niger, Aspergillus fumigatus, Penicillium frequentans, Rhizopus stolonifer, Pseudomonas s*pp., These moulds have lipolytic activities and their growth results in lipolysis (spoilage) of the palm oil. *Enterobacter* spp could also be present as it is an indication of faecal contamination particularly as a result of contamination from processors personal hygiene and display pattern in the markets [25] thereby posing serious challenge to

| Samples | OML | ORL | KLS | KLM | QVI | QRL | ZUP | ZYE |
|---|---|---|---|---|---|---|---|---|
| Colony count | 5.0 x $10^4$ | 3.2 x $10^4$ | 2.6 x $10^4$ | 2.4 x $10^4$ | 1.1 x $10^4$ | 2.3 x $10^4$ | 1.9 x $10^4$ | 2.1 x $10^4$ |

***Table 3:*** *Microbial count for the samples (cfu/g).*

health of consumers. It can therefore be suggested that the palm oil should be thoroughly heated but not to smoke point before consumption so as to reduce the microbial load.

## Conclusion

The free fatty acid is the most important criterion for determining the quality of edible oil, for consumption as well as for export. From the results obtained, the free fatty acid of the palm oil is high and this can be attributed to over-ripening of the palm fruits from which the palm oil was extracted. Poor handling during harvesting may further results in bruises leading to infestation by microorganisms and degradation of the oil by the lipase enzymes. High free fatty acid may also be due to environmental factors to which the oil is exposed to post-processing such as storage of palm oil in transparent packaging materials, display of palm oil in open market under sunlight and ultra violet radiation. The study concluded that there is need for improved processing, good handling and storage practices that would ensure high quality of palm oil sold in the markets.

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