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AN ASSESSMENT OF THE QUALITY INDICES OF NATIVE AND REGULAR PALM OIL PRODUCED IN EDO AND DELTA STATES

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ABSTRACT

Different brands of palm oil produced in parts of Edo and Delta states were classified as native (locally processed) or regular (industrially produced) and evaluated for their physical and chemical properties. Physical characteristics examined included oil color which varied between pale red and brick red, and specific gravity (SG) which ranged between 0.5 - 0.6. Olein-stearin ratio and the rate of spread of oil were variable. The free fatty acids in the different oil samples recorded 12.44 - 15.15mg/KOH/g. The saponification values varied between 202.0 mg/KOH/g and 210.8 mg/KOH/g while the iodine values were non-significantly ($p>0.05$) different between 49.07 - 50.93 Wij's. The variation in peroxide values were significant, ranged from 6.0 to 14.67meq/g. Variance analysis also showed some non-significant ($p>0.05$) as well as significant differences ($p<0.05$) in various chemical properties of the different native and regular palm oils from Edo-Delta. The variation in properties and quality indices indicated lack of standardization of process in Palm oil milling in Nigeria. Quality assurance through the introduction of modular design and process for small and medium scale palm oil mills is recommended.

Keywords: *Edo-delta, native, regular, palm oil, characteristics, properties and quality indices.*

INTRODUCTION

Oil palm tree, *Elaeis guineensi* (African oil palm) and *Elaeis oleifera* (American oil palm or marimpa palm), belong to the family Arecaceae and subfamily Arecoideae (Reeves and Weihrauch, 1979). It is about the most important economic oil crop in Nigeria! Palm oil is the major product; an edible vegetable oil derived from the mesocarp (reddish pulp) of the fruits that are borne in bunches which in turn are borne in clusters on the crown of each tree. The oil is widely consumed in homes and industries, as a cooking ingredient, and as an essential multipurpose low cost raw material for both food and non-food industries, around the world, wherein it is called by different local and tribal names (Armstrong, 1998; USDA, 2009; Obahiagbon, 2012). In Nigeria, palm oil is a versatile vegetable oil, consumed in virtually every part of the country, with many processed foods either containing palm oil or various ingredients derived from it (Ayodele, 2010). It has been estimated that about two liters of palm oil are consumed weekly by every Nigerian household of five (Ekine and Onu, 2008). The oil can be processed or blended to form a wide range of food preparations and products, some of which is are further used in the production of other useful products such as margarine, soaps, cosmetics, waxes candles, pharmaceuticals, biodiesels (Pleanjal *et al*, 2007), lubricating greases and other products and other confectionaries (Embrandiri *et al*, 2011). Naturally, palm oil is reddish in color due to having very high beta-carotene content! The mesocarp contains 41% saturated fat! Hence palm oil is one of the few highly saturated vegetable fats, semi-solid at room temperature. Like most plant-based products, the oil contains very little or no cholesterol (Behrman and Gopalan, 2005).

In Nigeria palm oil is produced by traditional methods, at subsistence and rural enterprise levels; and by industrial methods at, small and medium scale enterprise levels (SMEs). Many oil palm mills, operating as SMEs abound in Edo-Delta along with a few large scale industries such as Okhomu Oil Mill and Presco Oil Mill in Edo State, and Nsukwa Oil Mill, in Delta State. The capacity of the large scale processors is low in relation to the demand for palm oil in the region and elsewhere in the country. Thus much of the palm oil found in Nigerian markets is produced by the SMEs and the traditional micro - processors of which standards and quality assurance are uncommon. Hence also, much variation can be seen in the quality of palm oil sold in Nigeria markets. The variation is

supposedly due to culture and traditional systems of processing in different locations, as well as technology and scale of operation. Giving the increasing demand for the product, ascertaining the quality of various palm oils from locations in Edo-delta was thus the premise of this study. The objectives were to sample and assess different methods of oil palm processing in different locations; evaluate the physical and chemical properties of the various oils and compare these with standards palm oils produced by macro-industry.

Materials and methods

Location of study The study was conductrd in Edo and Delta States, both located in the equatorial rain forest belt of Nigeria. Edo is situate between latitude 6.2^0 N and longitude 5.6^0 E; has dense vegetation and high annual rainfall of about 2074mm, relative humidity ranging from 22-80% and a temperature range of 24-33^0C. Delta state lies between latitude 5^0 N and longitude 6^0E; has a relative humidity of about 62-85%; temperature range 28^0C to 34^0C; and an annual rainfall usually above 2,000mm. Laboratory work was undertaken at the University of Benin Central Analytical Laboratory.

Sources of Materials Eleven (11) samples of palm oils were obtained from the different local government areas. These included two (2) standard palm oil samples which served as the controls for the experiment - one was collected from the Nigerian Institute for Oil Palm Research (NIFOR) in Benin-City, while the other was supplied from International Marine Oil Company, Nsukwa, Delta.

Materials identification The nine (9) oil samples were identified by location or origin and then categorized as either general or native palm oil. **Regular Palm Oil** refers to palm oil that underwent all the unit operations or complete/normal production process; and usually from factory/processing mill. This type of palm oil is considered pure/normal and can be used for food preparations. On the other hand **Native Palm oil** refers to oil that underwent incomplete or partial processing, clarification was omitted. The oil may be native to rural community, due to traditional processing method, or may have peculiar characteristics, and cannot be used for all food preparations. It contains high level of impurities. The different oil samples were hence identified and collected into screw-cap, plastic bottles and labeled as follows:-

i. Samples from Edo State: USN – Uselu Native palm

oil, USR – Uselu Regular palm oil, AUR–Auchi Regular, EKR– Ekpoma Regular, NFS – NIFOR Standard palm oil.

ii. Samples from Delta State: UGN – Ughelli Native, UGR – Ughelli Regular, WRN –Warri Native, WRR – Warri Regular, AGR – Agbor Regular, NSS – Nsukwa standard palm oil.

Physical Characterization of Oil The evaluation of the physical characteristics was conducted for all the samples. **Color** was determined by visual examination of oil in petri dish before and after allowing standing at room temperature for a few days. **Specific gravity** was determined by measuring the weight of 5ml of the oil sample in relation to weight of 5ml of distilled water at room temperature. **Rate of Separation of oil (Olein:Stearin ratio)** was determined by measuring the length of the top clear liquid fraction (olein) and the bottom solid fraction (stearin) of carefully mixed and then delivered into screw-capped tube and allowing to stand at ambient temperature (25^0C)for a few days. **Rate of Spread of oil (viscosity)** was determined by measuring at different points the diameter of oil carefully discharged on center of sterilized petri-dish and allowed to stand for a 15mins. The distance from one end of the oil spread was taken at different points and subtracted from the main diameter of the petri-dish.

Chemical Analysis of oils The AOCS (2009) recommended methods and described by O'keefe and Pike (2010), were used in analyzing oil samples for free fatty acid content, saponification value, iodine value and peroxide value.

Free fatty acid was determined by titration and calculation. **Procedure** 1g of palm oil was weighed into a conical flask.

i. A neutral solvent solution of 20ml was added and shaken to dissolve properly.
ii. The solution was titrated with 0.1N NaOH.
iii. A blank was also prepared.

Calculation Free fatty acid value is calculated as follows;

$$FFA\ (oleic) = \frac{V \times N \times 28.2}{W}$$

FFA = free fatty acid as oleic acid. V = Volume of NaoOH titrant (ml). N = Normality of NaOH titrant (mol/1000ml). 28.2 = Molecular weight of oleic acid (g/mol) . W = Weight of sample used (g).

Saponification value was determined by back titration and calculation according to the

following procedure: 1g of the palm oil was weighed into a conical flask.

- 25ml of alcoholic potassium hydroxide solution was added.
- The solution was boiled gently on a hot plate, also shaking frequently until the sample is clear and homogenous indicating complete saponification.
- 1ml of phenolphthalein indicator solution was added and titrated with 0.5N of HCl.
- A blank was prepared and also titrated with 0.5N HCl.

Calculation Saponification *value* = $\frac{(B - S) \times N \times 56.1}{W}$

Where saponification value = mg KOH per 1g of sample. B = volume of titrant (ml) for the blank. *S = volume of titrant (ml) for sample N = normality of HCl (mmol /ml)*

56.1 = molecular weight of KOH (mg/mmol). W = weight of sample.

Iodine value was measured also by titration in accordance with standard procedure Procedure 1g of the palm oil sample was weighed into a conical flask.

i. 10ml of chloroform solution was added to dissolve the palm oil.
ii. 25ml of Wijs reagent solution was added and left in a dark place for 30mins.
iii. Then 20ml of 15% potassium iodide solution was added.
iv. 100ml of freshly boiled water was added.
v. 1ml of starch indicator was also added.
vi. Then the solution was titrated with 0.1N sodium thiosulfate solution.
vii. A blank was prepared and titrated with 0.1N sodium thiosulfate solution.

Calculation The iodine value of the sample is calculated as follows;

Iodine value = $\frac{(B-S) \times N \times 12.69}{W}$

Where iodine value = gram of iodine absorbed per 100g of sample

B =volume of titrant (ml) of blank. S = volume of titrant (ml) of sample

N = normality of $Na_2S_2O_3$ solution thiosulfate (mol/100ml)

12.69 = molecular weight of iodine (g/mol). W = weight of sample (g).

Peroxide value was estimated following this procedure: 10g of

palm oil was weighed into a conical flask.

i. 20ml of mixed reagent was added and boiled gently in a water bath.
ii. 20ml of 5% potassium iodide solution was added.
iii. 1ml of starch indicator was added.
iv. The solution was then titrated with 0.2N of sodium thiosulfate
v. A blank sample was prepared with it.

Calculation ***P****eroxide value*

$$= \frac{(S - B) \times N \times 1000}{W}$$

Where peroxide value = milliequivalent peroxide per 1g of sample. B = volume of titrant (ml) for blank. S = volume of titrant (ml) for sample. N = Normality of $Na_2S_2O_3$ *solution (meq/ mol).1000 = conversion of units (g/kg).S W = weight of sample.*

Statistical Analysis The statistical analysis was carried out using Genstat method of analysis. Genstat is a general statistical package developed by a team led by John Nelder (Payne, 2009). The data generated were subjected to statistical analysis of variance (ANOVA) procedure of Genstat 12th edition at 5% probability level. Occurrence of significant means will be separated using Duncan Multiple Range Test(DMRT) of the same statistical software (Duncan, 1955).

Results

The study was conducted to determine the quality characteristics of different types of palm oil produced locally in Edo and Delta states of Nigeria. The physical characteristics of the different oil are summarized in Table 1. The results show that all the samples had specific gravity lesser than that of water, with samples USN, UGN and NFR having the highest specific gravity of 0.60 and sample USG having the lowest specific gravity of 0.55, thus indicating that water is more dense than palm oil. The result also shows that the stearin fraction was higher than the olein fraction for all the palm oil samples evaluated with samples NFR and NSK having the highest fraction. The rate of spread also varies among the different samples.

Table 1: Physical Characteristics of Palm Oils from Edo and Delta State

Samples	Color	Specific Gravity	Olein/stearin ratio	Rate of Spread
USN	Dark red	0.60	2:18	Medium
USR	Red	0.55	3:16	Low
AUR	Brick red	0.58	1:2	Medium
AGR	Dark red	0.59	3:7	High
UGN	Brick red	0.60	1:6	Medium
UGR	Pale red	0.57	5:14	Medium
WRN	Brick red	0.58	3:13	Low
WRR	Brick red	0.59	3:15	Medium
EKR	Pale	0.58	7:10	Medium
NFS	Pale red	0.60	0:20	Medium
NSS	Brick red	0.59	0:17	Medium

The quality characteristics evaluated include the free fatty acid, saponification value, iodine value and peroxide value. The results are shown in Table 2! Free fatty acid values (FFA) obtained for the palm oil samples ranged in value from 12.44 to 15.15 mg/KOH. The results show that the free fatty acid value of sample AUG was not significantly different ($P<0.05$) from the free fatty acid values of sample WRG and EKG. Similarly, the free fatty acid value of samples USG, AGG, UGN, NFR, NSK, USN, UGG, WRN were not significantly different ($P<0.05$).

Table 2: Chemical Characteristics of Palm Oils from Edo and Delta State

Sample Code	Free Fatty Acid(mg/KOH/g)	Iodine value (Wij's)	Saponification Value (mg/KOH/g)	Peroxide Value (Meq/g)
AUR	15.15 ± 0.16^{a}	50.63 ± 0.22^{ab}	208.0 ± 0.48^{b}	14.667 ± 0.67^{a}
WRR	14.59 ± 0.32^{a}	49.83 ± 0.26^{cd}	202.0 ± 0.81^{e}	12.000 ± 1.16^{ab}
EKR	14.31 ± 0.16^{ab}	50.93 ± 0.15^{a}	203.4 ± 0.57^{e}	10.667 ± 1.33^{abc}
USR	13.56 ± 0.25^{bc}	49.07 ± 0.12^{e}	203.8 ± 0.47^{de}	10.000 ± 2.31^{abc}
AGR	13.18 ± 0.16^{cd}	49.81 ± 0.40^{d}	210.8 ± 0.47^{a}	6.000 ± 1.16^{c}
UGN	13.18 ± 0.16^{cd}	50.93 ± 0.12^{a}	206.6 ± 1.23^{bcd}	10.000 ± 2.31^{abc}
NFS	12.81 ± 0.74^{cd}	50.93 ± 0.11^{a}	204.8 ± 0.81^{cde}	9.333 ± 1.76^{bc}
NSS	12.62 ± 0.11^{cd}	49.98 ± 0.32^{bcd}	203.4 ± 0.81^{e}	8.667 ± 0.66^{bc}
USN	12.62 ± 0.17^{cd}	49.98 ± 0.32^{bcd}	202.4 ± 1.69^{e}	8.000 ± 1.16^{bc}
UGR	12.62 ± 0.43^{cd}	50.63 ± 0.06^{ab}	207.1 ± 0.93^{bc}	9.333 ± 1.76^{bc}
WRN	12.44 ± 0.25^{d}	50.80 ± 0.18^{a}	209.0 ± 0.81^{ab}	9.333 ± 1.33^{bc}

*Means with different superscript are significantly different at 5% probability level ($P<0.05$).

Discussion

Palm oil quality is affected by post-harvest handling and processing methods and techniques; as well as by the conditions of storage which may affect the physical and biochemical characteristics of the oil. The quality of oils can be measured by various indices! For example, a good quality palm oil is characterized by a low free fatty acid (FFA) content, usually free from impurities and has a good odor. Poor quality palm oil has high FFA; and hence not ideal for consumption because it poses several health risks which can impact adversely on the functioning of organs such as the heart, kidneys and lungs, (Esterhuyse, 2005). Other indices of oil quality include such as peroxide value, iodine value and saponification number. Those indices are usually measured to determine the food and economic value of the oil. Okechalu *et al*. (2011) sampled oil palm sold within Jos Metropolis and found that the FFA ranges from 2.67 – 4.20%. Onwuka and Akaerue (2006) found that the % FFA of palm oil differs according to the different methods of processing. They found that the FFA of large-scale industrially processed palm oil is 0.97%, while oil processed using traditional aqueous oil extraction method had a FFA of 2.6 – 2.9%. Likewise, Ngando *et al*. (2012) reported % FFA of traditionally (6.39%), semi-mechanical (5.00 – 10.26%) and industrially (4.71%) processed palm oil in Cameroon. Basically, FFA is the widely used method for examining the quality of palm oil, as it must not exceed 5% expressed as palmitic acid (Ngando *et al*., 2011). The high FFA level reported in this study may be attributable to the post handling techniques employed in the processing of palm oil such as time of fermentation which result to continuous build up of FFA in the mesocarps of the fruit under the action of lipase. The FFA content increases during autocatalytic hydrolysis (Ngando *et al*., 2011). However, fatty acids are present in oil as part of triacylglycerol molecules. The presence of free fatty acid moisture in palm oil is an indication of the impairment of oil quality. This is usually attributed to the activities of lipase that is present in the palm oil (Ngando *et al*., 2006; Odunfa, 1989). High FFA can also be caused by the exposure of the fresh fruit bunch to sunlight prior to fermentation (Okechalu *et al*., 2011), and the action of fungi on the glycerides. FFA can also be generated by lipases from contaminating microorganisms (Houria *et al.*, 2002; Odunfa, 1989). High FFA can be caused by over-ripe fruits. Tagoe *et al* (2012) reported that microbial infestation of the fresh fruit bunches and the FFA of the processed oil increases with the length of storage. Consequently,

the differences in the FFA content of the CPO collected from the different sites could be associated with the extent of ripeness ofthe palm fruit prior to oil extraction, and the duration of the fermentation during processing as well as the effect of the bruises resulting from slicing of the fresh fruit bunch.

The iodine value which is the measure of the level of unsaturation in the oil samples (AOCS, 1993) ranged from 49.07 to 50.93 Wij's. The iodine value obtained for sample NFR was not significantly different ($p<0.05$) from those obtained for samples AUG, EKG, UGN, UGG and WRN. While iodine value obtained for sample USG was significantly different ($p<0.05$) from the iodine value obtained for the other samples. Iodine value obtained for sample AGG was not significantly different ($p<0.05$) from iodine values obtained for samples WRG, NSK and USN. The iodine values obtained were within the standard range of 45 – 53 Wij's as recommended by SON (2000) and NIS (1992). However, the values obtained indicate that the oil samples are highly unsaturated and therefore susceptible to oxidation. This may be due to poor storage conditions. The addition of antioxidants may be necessary to prolong the storage stability of the oils. The high iodine values thus indicate the high level of unsaturation in the palm oil which makes them well suited for making oil paints.

The saponification values (SV) obtained for the palm oil samples (Table 2) ranged from 202.4 to 210.8 mg/KOH/g. However, in an experiment carried out by Udensi and Iroegbu (2007), it was observed that the saponification values obtained for the palm oil samples from Umuahia, Abia and Umuopara ranged from 192.64 to 198.03mg/KOH/g. Saponification values obtained for sample AGG was not significantly different ($p<0.05$) from that obtained for sample WRN. Also, saponification value obtained for sample AUG was not significantly different ($p<0.05$) from the saponification value obtained for WRN. Saponification values obtained for samples WRG, EKG,USG, NFR, NSK,USN were not significantly different ($p<0.05$). However, saponification values obtained for sample AUG, UGN and UGN were not significantly different ($p<0.05$). The high saponification values of the palm oil samples above the specified range of 195 to 205mg/KOH/g indicate that the oils sampled in this study will be most suitable for soap making.

The peroxide values ranged from *6.00 to 14.667 meq/g* and are related to the standard value of 10meq/g

specified by SON (2000) and NIS (1992). Peroxide values obtained for samples AUG and WRG were not significantly different ($p<0.05$). Also, peroxide values obtained for samples AGG, EKG, USG, UGN, NFR, NSK, USN, UGG, WRN were not significantly different ($p<0.05$). In the experiment carried out by Udensi and Iroegbu (2007), they also obtained peroxide values ranging from 7.90 to 8.80 meq/kg which were closely related to the standard value of 10 meq/kg recommended by SON (2000) and NIS (1992). The peroxide value determines the extent to which the oil has undergone rancidity, thus it could be used as an indication of the quality and stability of fats and oils. The peroxide values obtained in this work indicate that spoilage may have advanced in some of the samples, resulting in the off-odors or off-flavors observed. Such spoilage may produce free radicals in the oil which could become harmful to human health if not subjected to further processing (Tagoe *et al*., 2012).

Conclusion and Recommendation

The study evaluated the types and quality characteristics of palm oil produced in Edo and Delta states of Nigeria. The findings indicate that the free fatty acid content of the samples were higher than the maximum free fatty acid content of 3.5mgKOH/g of oil specified by SON (2000). Generally the free fatty acid (FFA) shows the level of rancidity taking place in the oil. Hence, the values indicate high level of rancidity in the palm oil sample. The addition of antioxidants to prolong the storage stability of the oils is recommended. The prospects of the palm oil economy in Nigeria are high. Hence the technology of processing need be stepped up in Edo and Delta States and other oil palm producing and processing states in the country. This recommendation is based on the fact that the reference palm oil samples from NIFOR and International Marine Oil Company also assessed as standards in this study, recorded saponification, iodine and peroxide values which fall within the specified ranges. This is because of the standard procedures employed in those oil processing companies.

Hence it is worthy to recommend that fresh oil palm fruits free from bruises should be processed in order to obtain oil of low free fatty acid content. Processors should carry out standard methods of processing of palm oil in order to achieve oil of good quality. Standard equipment should also be used to ensure the quality of the oil is preserved in storage.

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