International Journal of Scientific Research in Biological Sciences
Vol.8, Issue.1, pp.41-48, February (2021)
Research Paper
E-ISSN: 2347-7520

Physicochemical and Thermal Properties of Locally Produced Oil Palm from Unwana Palm Plantation in Afikpo North Local Government of Ebonyi State, Nigeria

R.E. Nnam[1]*, V.O. Obinna[2], N.J. Emerenini[3], N.U. Okoro[4]

[1,2,3,4]Department of Food Technology, Akanu Ibiam Federal Polytechnic Unwana, Ebonyi State, Nigeria

[*]*Corresponding Author: firstauthor_raphelnnam@gmail.com, Tel.: +2348063013921*

Available online at: www.isroset.org

Received: 12/Dec/2020, Accepted: 10/Jan/2021, Online: 28/Feb/2021

Abstract—Unwana as one of the semi-urban communities in Ebonyi State, Nigeria is blessed with resources one of which is a palm plantation. This plantation is a major source of red palm oil consumed by both the community and its environs. This oil is consumed in its raw form without further refinement. Therefore, the need to assess the quality of the unrefined palm oil produced from the palm plantation cannot be overemphasized hence this research. The research is geared towards ascertaining whether the locally produced palm oil produced meet the required global standard for crude palm oil. The characteristic of the locally produced palm oil was investigated for its physical, chemical and thermal properties. The physical properties evaluated included Specific gravity, Viscosity and Refractive index of the oil; Chemical properties are the moisture content, FFA, Total Carotenoids, Total Polar compound, Saponification Value, Iodine value, Peroxide value and Ester value while for thermal properties, the melting, smoking, flash and fire points of the oil were evaluated. From the result of the analysis, the three properties considered fell within the recommended value for nutritional limit by SON, FAO and WHO. This shows that the locally produced red palm oil from Unwana plantation is healthy and fit for consumption.

Keywords—Unwana, Palm oil, Physicochemical properties, Thermal properties; Oil mil; Nigeria

I. INTRODUCTION

Palm oil is an extraction from the fleshy mesocarp of palm fruit (*Elaeis guineensis*) [1]. It is an edible vegetable oil gotten from the pulp of the fruit of the oil palm [2]. Two different types of oil are produced from Oil palm *(Elaeis guineensis).* These include palm oil and palm kernel oil with a yield of about 20-22% oil content coming from the fibrous mesocarp as palm oil and 10% of the total yield coming from the white kernel flesh [3]**.** While palm oil originates from Southeast Asia and Equatorial Africa [4, **5, 6]**, Nigeria, Malaysia and Indonesia are the major producers of palm oil in the world [1]. As a vegetable oil, oil palm is the most treaded edible vegetable oil in the world that is used both as food especially as a cooking oil and non-food purposes [4, 7, 8, 9].

Crude palm oil is a complex mixture consisting majorly of glycerides as the major component while carotenoids, tocopherols, tocotrienols, phytosterols, sterols, glycerolipids, squalene and phosphatides represent the minor components [10, 11]. The function of carotenoids, tocopherols and tocotrienols in the oil is to maintain the stability and quality of the palm oil. They also act as biological antioxidants [12]**.** The tocopherols and tocotrienols act as anti-cancer, anti- inflammatory agents [13], control atherosclerosis, and decrease cholesterol.

The oil is rich in palmitic acid, β-carotene and vitamin E. [6]. It has been shown that Crude palm oil is the richest natural source of carotenoid. It contains about 15 times more carotenoid than carrot [14]. Carotenoids are chemical compounds that when absorbed by the human body can be converted into vitamin A. It improves immune and cardiovascular functions through different body metabolisms. It also serves antioxidant, protecting the cells and tissue from the damage that can be caused by free radicals that can cause health challenges such as heart disease and cancer, as well as general cellular ageing, atherosclerosis, arthritis and Alzheimer's disease [15, 16]. When palm oil is deacidified and deodorized it retains 80% of the original carotenoids, making it a remarkable source of vitamin A [17]. The high beta-carotene content of oil palm as a tropical fruit, gives it the orange-red to brownish or yellowish-red colour [18] making it known as red palm oil.

Palm oil is an economically important and widely used vegetable oil, as raw material for both food and non-food products [19]. About 80% of products gotten from oil Palm are used for edible purposes [20, 21]. This means that all the products derived from palm oil fruit has useful application of which majority of it is for edible food applications. Palm oils unique composition makes it versatile in its application in food manufacturing and in the chemical, cosmetic and pharmaceutical industries. In food industries, palm oil is the choice for manufacturing solid fat products. Palm oil olein and stearin are popularly used worldwide in making margarine, shortenings and confectionery, and in frying snack foods [22]**.**

Palm Oil use in food manufacturing has continually grown within the last decade not because of its competitive price when compared with other vegetable oil but because it has some qualities that distinguish it from other vegetable oil [23, 24**].** These distinctive qualities include, natural excellent oxidative stability, unique solid content profile, high nutritional value, free of *trans* fatty acids and cholesterols and antioxidant properties [24]. The excellent oxidative stability of oil palm steams from the fact that it is high in monounsaturated fatty acid (oleic acid) and vitamin E, and low in polyunsaturated fatty acid [19]. Therefore foods processed or produced with palm oil can be kept for a long period of time and also have a low degree of rancidity. The high content of natural antioxidants of palm oil and its stability at high temperature makes it excellent as a deep frying medium. Most vegetable oils such as corn oil, soyabean oil, cottonseed oil and canola oil, require hydrogenation as a prerequisite to increase their saturated fatty acid content before they can be used in food formulations; however, palm oil has high solid-glyceride content (due to its semi-solid nature), giving the required consistency without hydrogenation [22, 25]. Therefore, the importance of quality of palm oil in our food formulations cannot be overemphasized.

Palm oil is also used in the manufacture of soaps, detergents and other surfactants. It is a good raw material for producing oleo chemicals, fatty acids, fatty alcohols, glycerol and other derivations for the manufacture of cosmetics, pharmaceuticals, household and industrials manufacture from palm oil and palm kernel oil are now popular for the manufacture of environment friendly detergents as they are readily biodegradable palm fruit oil is consumed world wide in more than 100 countries.

The purpose for evaluating the physicochemical properties of oil is to determine the quality, purity and identification of the oil. The physical and chemical parameters used to characterize oil include iodine value, saponification value, peroxide value, free fatty acid value, density, and viscosity. However the peroxide value, free fatty acid value and density vary with the location of the plant [2]**.**

Recently, the issue of the adulteration of palm oil like producers and marketers intentionally adding chemical substances to enhance quantity, appearance, viscosity and etc. with the sole purpose of increasing the profit margin abounds. This substance practically makes it impossible to physically differentiate between a good palm oil and the adulterated one. The issue of adulteration calls for serious concern because of the associated health hazard and with the sudden rise in cases of cancer, organ damages and heart diseases, it has become highly necessary for Nigerians to pay attention on the quality of palm oil used in our everyday consumption and in food formulation [2, 26].

Therefore, the need to characterize vegetable oils both locally processed and sold in our various local markets cannot be treated with levity; hence this work is looking at the quality assessment of oil palm produced locally from Unwana in Afikpo North Local Government of Ebonyi State, Nigeria.

II. RELATED WORK

[1] evaluated the quality of palm oil by determining the quality of Fatty acid methyl esters (FAME), Free fatty acids (FFA %), peroxide value (PV), Total Polar compounds and Total carotenoids (TC). The study showed that the crude palm oil (CPO) had a balanced fatty acid composition in which the level of saturated fatty acids is almost equal to the level of unsaturated fatty acids. The research further showed that the saturated and unsaturated fatty acids values were within the range for Brazilian palm oils but more unsaturated than Nigerian oils. [14] in assessing the quality of palm oil sold in south western Nigeria discovered that the FFA content and moisture content of all the sample of palm oil used exceeded the acceptable limit of 5% and 0.3% respectively, required of a quality palm oil [27, 28]. However, the Saponification and peroxide values of the oil samples that ranged between 157.20 - 212.84 mg/KOH/g and 7.15 - 10.35 meq/k for saponification and peroxide value respectively are comparable to the standard value recommended by [29, 30]**.** The research attributed the high value of FFA to over-ripening of the palm fruits, poor handling and processing method.

[31]**,** in a related research, this study showed that palm oil produced at different local factories in Imo State, Nigeria displayed varied physical and chemical properties which tend to reflect the stability and quality of the palm oil. The palm oil sample from Okigwe and Umuagwo showed the best physical and chemical composition compared to other samples studied.

The study was limited to Imo State, therefore the outcome of the research cannot be said to be true representative of palm oil from all parts of Nigeria.

[32] evaluated the physicochemical properties of different grades of Malaysian high free fatty acid crude palm oil (HFFA-CPO) and low free fatty acid crude palm oil (LFFA-CPO)) to determine their applicability as edible oils. The parameters evaluated are free fatty acids (FFAs%), iodine value, hydroxyl value, unsaponifiable value, moisture content for HFFA-CPO and LFFA-CPO. In general, the physicochemical properties of HFFA-CPO and LFFA-CPO are consistent with the standard Malaysian crude palm oil, with the exception of FFAs%, hydroxyl value, and moisture contents.

([2] analyzed the physicochemical properties of palm oil within Abia State, Nigeria to determine the level of adulteration. From the analysis carried out, it was discovered that the physicochemical properties of all the samples evaluated were within the [29, 30] recommended range.

III. METHODOLOGY

A. Collection of samples

The palm fruits samples used in this work were all from *Elaeis guineensis dura* (Ojukwu) obtained from Unwana palm plantation, Ehugbo Palm plantation and Amasiri palm plantation all in Afikpo North L. G. A, Ebonyi State Nigeria.

B. Extraction of palm oil from mesocarp oil palm varieties

A modification of the method of [33] was used to extract the oil from mesocarp. The freshly harvested ripe oil palm fruits were separated from the bunch and boiled in a large container for about 4hours. The mass of pulp was produced by pounding the boiled fruits in a morta. The whole mass was immersed in water, stirred and the crude oil, which rose to the surface, was skimmed off into another pot. The fibres were removed from the water manually and finally the nuts were collected and separated from the remaining fibres. The crude oil thus obtained was boiled in smaller vessels where any fibre still present sank to the bottom. The oil was again skimmed to further remove traces of water.

C. Experimental Analysis

Determination of saponification value: This was done with the method described by [10] and calculated using the equation:

Saponification value = ((b – a) x 28.05)/Weight of sample

Where b = titre value of blank; a = titre value of sample;

28.05= mg of KOH equivalent to 1 ml of 0.5 M HCI

Determination of acid value and free acid content: the acid and free fatty acid content of the palm oil was determined using the method described by [10] and calculated using the equation: % Free fatty-acid = Acid value/2

Determination of ester value: Ester value was obtained by finding the difference between the saponification values and acid value [31]**.**

Determination of beta-carotene: The method described [10] was used.

*Determination of Specific gravity***:** The analysis was carried out according to the method reported by [31]**,** and calculated as follows**:**

Specific gravity= $\frac{weight\ of\ Xml\ of\ Oil}{weight\ of\ Xml\ of\ water}$

Determination of peroxide value: Determined by the method described by [32].

Determination of Total Polar compounds: The total polar compound (TPC) content was determined gravimetrically according to a mini column method described previously, with slight modification by [1].

Determination of iodine value: Palm oil (2g) was dissolved in 10 ml of cyclohexane in a 250-ml conical flask. 20 ml of Wij's solution was then added to it and corked. The mixture was allowed to stand for 30 min in the dark at room temperature after which 20 ml of 10% potassium iodide solution was added. The resulting solution was titrated with 0.1M Sodium thiosulphate ($Na_2S_2O_3$) using starch as indicator. Also, a blank solution was titrated with $Na_2S_2O_3$. The Iodine value was calculated thus:

Iodine value = $\frac{[B-S]\times N\times 12.69}{weight\ \ of\ the\ oil\ sample}\ x\ 100\%$

Determination of viscosity:

The palm oil sample was poured into a Carnonfenske viscometer using a short length hose. The time taken in seconds for the oil to flow from the lower meniscus of the second arm of the viscometer to the upper meniscus of the short arm was then noted and recorded. The viscosity of the oil was then calculated by multiplying the viscometer constant by the time of flow of the oil. Four readings were taken and the average was calculated.

Determination of refractive index: Abbes' refractometer was used to determine the refractive index according to the method reported by [34]**.**

Determination of melting point

The melting point of the oils and their blends were determined using a Differential Scanning Calorimeter (DSC) according to [35]**.**

Determination of Smoking point

The smoke point determination was done using the method reported by [31]**.**

Determination of Fire and Flash point:

The smoke, fire and flash points were determined according to the method of [36].

IV. RESULTS AND DISCUSSION

Table 1: Physical Properties of locally Produced Palm Oil from Unwana Palm plantation

Properties	**Units**	**Unwana Oil**	**Standard (SON)**
Specific gravity	g	0.903	0.5-1
Viscosity	cst	165.80	-
Refractive index	^{0}Bir	1.455	1.454-1.456

Table 2: Chemical Properties of locally Produced Palm Oil from Unwana Palm plantation

Properties	**Units**	**Unwana Oil**	**Standard (SON)**
Moisture content	%	0.14	0.01-0.3
Iodine Value	mg/100g	49.60	45-53
saponification value	mg/KOH/g	203.50	190-209
Acid value	mg/KOH/g	2.82	4
Peroxide value	$mEqkg^{-1}$	8.36	10
Free fatty Acid	%	1.41	5
Ester value		200.68	
Total carotenoids	mg/kg	858.26	1000
Total polar compound	%	3.4	3.2-3.8

Table 3: Thermal properties of the locally Produced palm oil from Unwana Palm plantation

Properties	Units	Unwana Oil
Melting point	°C	**34**
Flash point	°C	**232.98**
Fire point	°C	**232.50**
Smoking point	°C	**233.0**

DISCUSSION

A. Physical Properties

The refractive index represents the number of carbon atoms present in the free fatty acid composition [37]. For this study, the refractive index of the oil samples was 1.455 (Table 1). The high refractive index of these oils is attributable to the high number of carbon atoms in their fatty acid composition. The specific gravity of the oil is 0.903. This result agrees with earlier work reported by [10, 31, 38, 39]. Viscosity expresses the thickness or thinness of a material. It evaluates the rate at which a liquid, semi-liquid can move due to its thickness or stickiness. Therefore, viscosity is a temperature dependent property. It decreases with increase in temperature [38]. In this study, the viscosity of the oil sample s 165.80, at 40°C (Table 1). This outcome does not agree with earlier research carried out by [32] though at different temperature of 28°C but relatively close to the result obtained by [38] at 40℃.

B. Chemical Properties

According to [10]**,** saponification value is an indication of the amount of fatty saponifiable material in oil or fat. This implies that saponification value shows the molecular weight of triglycerides present in the oil. Saponification value (SV) is an estimation of oil oxidation when stored. It also shows the level of composition of the oils [14, 32]. The higher the saponification value, the higher the proportion of low fatty acid as the molecular weight of triglycerides present is inversely proportional to the low fatty acid (average chain length (C4 - C12)) present in the oil [40]. SV is an important parameter for characterizing the industrial use of oil, specifically for soap production Saponification values is an important parameter when determining the industrial application of vegetable specifically as it concerns soap production [41, 42]. A very soluble soap is made from oil with a high saponification value [43]. The saponification values obtained from the study falls within the acceptable range value for palm oil as can be seen from Table 2. It can be used to produce soap of good solubility. The value is 203.50mg/KOH/g. The obtained result agrees with the result gotten by [10, 31, 32]**.** When a vegetable oil has a low Saponification Value, it can be used as raw material for candle, and lubricants [44]. The higher aliphatic alcohols, tocopherols, carotenoids, phytosterols, tocotrienols, coenzyme Q, and squalene comprise the unsaponifiable matter of crude palm oil [45.

Table 2 show that ester value obtained from the study is 200.68. The values obtained agree with earlier work reported by [10, 14, 32]. However, the result is lower the 172.86 reported by [31].

Crude palm oil as a complex mixture is principally made up of glycerides that constitute the major component of the oil and carotenoids, tocopherols, tocotrienols, phytosterols and phosphatides representing the minor components [10]. When palm oil is refined by deacidification and deodorization it enables the retention of most of the carotenes and vitamins in the refined oil. About 80% of the original carotenoids are retained, making it a remarkable source of vitamin A [17, 43]. The ability of red palm oil (milder refined oil) to retain a large portion of its carotene and vitamin (A and E) makes it being considered as one of the richest plant source of carotenes [46]. Carotenoids are responsible for the variations in colour observed in palm oil and other various vegetable oils. The Alpha-carotene, β-carotene, and cryptoxanthin are responsible for carotenoids being a precursor of vitamin A with Beta-carotene being the most potent of them all. The functions of Vitamin A in the human body include vision, growth, cellular differentiation and other physio- logic functions [1, 6, 47]. Carotenoids play a significant role in the quality of oil during storage. It is the antioxidants that may provide oxidative stability to the oil. The stability of oil depends partly on the extent of deterioration during heating or storage. In living tissues, lipid constituents such as unsaturated fatty acids are sufficiently stable by natural antioxidants and enzymes that prevent lipid oxidation [10]. However, living tissues lipids rapidly deteriorate once they are separated from plant and animal. In this study, it was observed that total carotenoids content of the palm oil sample is 858.26mgkg^{-1} as shown in Table 2. This outcome is within the range recommended by [48, 49], between 500-1000mgkg^{-1}. It is also comparable to the result reported by [1, 6, 10, 50]

Palm oil is used as means of heat transfer from the fryer to the food during frying of food. The quality of oils and fats during the frying process has a major influence on the quality of the final product [51]. This frying process causes oxidative and hydrolytic reactions of the oil due to the thermal treatment which occurs at high temperatures (160°-195°C), given to the oil. The process is also carried out in the presence of air, metal container and moisture, [52, 53]. The resultant effect of the heat treatment is the formation of numerous decomposition products (volatile and non-volatile compounds) formed as a result of both the physical and chemical changes that occur in the oil [54, 55]. Therefore, the TPC concentration shows how good the overall quality of the initial oil is. The hydrolysis reaction which is the component of TPC includes polymerized triacylglycerols, oxidized triacylglycerols, diacylglycerols and free fatty acids [1]. General, TCP acceptable range for palm oils is from 3.2% to 3.8%, but 24-27% for commercial frying oils. However, 24-27% is exclusive for European countries [56, 57]. As can be seen from Table 2, the TCP of the oil sample is 3.4% and in agreement with [48, 49, 56, 57]. While [1] agrees that the standard of TCP for palm oil ranges from 3.2% - 3.8%, the result it obtained was almost 5 times that obtained in this research, [58, 59, 60] reported 7%, 6.8-7.7% and 6%, respectively for polar compound values.

The reliability of free fatty acid (FFA) makes it the most important criterion or parameter for quality and hydrolysis determination of consumable oil. This is because deterioration of fat leads to the release of free fatty acids (FFA) from triglycerides. The amount of free fatty acid (FFA) liberated shows the level of spoilage [33]. It also plays an important role when investigating the thermal stability of palm oil [10]. The quantity of FFAs present in the oil shows the level of degeneration and quality of the edible oil. The value of FFAs present in the oil is affected by duration of palm fruit seed storage and the conditions under which the seeds were stored [61]. Conventionally, the value of FFAs in oil should not exceed 5% [1, 2, 10, 31, 32, 48, 49, 62], however, high value of free fatty acid in Crude Palm Oil is attributable to the processing method selected and rottenness of the fat leading to the release of more FFAs from triacylglycerol [32]. The lipase in the mesocarp of the palm fruit carry out the hydrolysis of triacylglycerol through fermentation thereby releasing the free fatty acid [1, 32]. Upon maturing, this enzyme is made active when the seed of palm fruit is bruised or microbial contamination. The degeneration of triacylglycerol in the oil is accelerated by light and temperature [32, 63]. When the oil is extracted from the palm oil seeds, the lipase becomes inactive, however, due to the autocatalytic hydrolysis that occurs when oil is stored, the FFA content of the oil may continue to increase during storage [64, 65]. From the study (Table 2), the FFAs of the oil sample falls within the approved nutritional limit of 5% as reported in the literature [1, 2, 10, 31, 32, 48, 49, 62]. The value is 1.41. The result obtained is in agreement with result reported by [2, 3, 51] but disagrees with the result reported by [10, 31, 32]**.**

The acid value is an important parameter when dealing with the oil industrial purposes or its human nutritional value [66]. The acid value is the number of milligrams of the potassium hydroxide necessary to neutralize the free acid in 1 g sample. The acid value is often a good measure of the breakdown of the triacylglycerol into free fatty acids, which has an adverse effect on the quality of many fats. The acid value was determined to be 2.82 mg/KOH/g. According to literature, the acid value (oleic acid) of oil for food applications should not exceed 4% [48, 49], which indicates the acid values of the study sample falls within the nutritional limit.

The moisture content of oil is an indicator of the rate of Free Fatty Acid (FFA) formation since FFAs depend on hydrolysis reaction [67]. It is an indication of any food's water activity (aw) [68] and therefore an important parameter in assessing the quality of palm oil. High moisture content is an indication of ease of spoilage and rancidity as well as short shelf-life of palm oil [31]. When the water content in oil is greater than the solubility, the water will exist in droplets or emulsion state that influences the rate of hydrolysis reaction. However, the solubility of water in palm oil is very low about 0.3% (max) at room temperature [69]. From the result of the analysis, the moisture content of the oil is within the range of Nigerian crude palm oil standard [29]. The moisture content of the oil is 0.14% as shown in Table 2. By implication, the oil will not become much rancid over time and therefore of high quality.

The peroxide value is an index of the degree of oil oxidation caused by the activities of lipolytic enzymes such as peroxidase and lipoxygenase. Hence the primary products of lipid oxidation are hydroperoxides. Peroxide value measures the freshness of the lipid matrix and oxidation of oil especially during storage [10, 14]. The peroxide value obtained from this study as shown in table 2 is 22.98 meq/kg which is comparable with the standard value of 20-42meq/kg [48, 49]. This result agrees with reported work of [10, 14, 33].

Iodine value shows the level of unsaturation in vegetable oil and can be used for dictating adulterated vegetable oil [14]. The quantity of iodine in mass, absorbed by 100g of oil gives the iodine value of the oil as the oleic acid series combine with a definite quantity of iodine. Therefore, the iodine value is a measure of the amount of unsaturated fatty acids present in oil or fat. It is consistent for particular oil or fat, however, the exact figure obtained depends on the particular technique employed [14, 31]. The iodine value result obtained in this study is presented in Table 2 to be 49.60 Wij's. The results obtained from the analysis are within the standard range of 45 – 53 Wij's as recommended by [29, 30]**.** The result is also comparable to the results obtained by [32, 33]. The result is however higher than those obtained by [10, 31, 66] but lower than the results of [14, 70]**.**

C. Thermal properties

The melting point of a vegetable oil indicates the state of the oil at room temperature. The melting point obtained from this study ranged between 34°C (Table 3). These values are within the 27 - 50°C recommended by [29]. The temperature shows that the oil will remain liquid at room temperature. The obtained result is comparable to that obtained by [10, 14, 31]**.**

The flash point is an indication of the quality of oil when used for frying purposes. When the value of flash point is high, it shows that the palm oil is good for frying. From the study obtained, the flash/fire point for the oil sample is 232.98°C and 232.50°C respectively. The flash/fire point shows responses of the sample to heat and flame under controlled conditions [14, 38]. The result of the flash and fire point obtained is comparable to that obtained by [38] but higher than the one obtained by [2]**.** The smoke point which indicates that the oil is good for frying is 233.00°C. The smoking point obtained from this research is comparable to that obtained by [3, 14] but higher than the one obtained by [2, 31]**.**

V. CONCLUSION AND FUTURE SCOPE

Unwana as one of the semi-urban communities in Ebonyi State, Nigeria is blessed with resources one of which is a

palm plantation. This plantation is a major source of red palm oil consumed by both the community and its environs. This oil is consumed in its raw form without further refinement. The quality of the locally produced palm oil from Unwana palm plantation need to be investigated. This is to ascertain the level of adulteration of the produced oil. The physical, chemical and thermal analysis of oil produced from the said plantation was successfully evaluated. The free fatty acid as the most important criterion or parameter for quality and hydrolysis determination of consumable oil was evaluated. This is because, the amount of free fatty acid (FFA) liberated shows the level of spoilage. Conventionally, the value of FFAs in oil should not exceed 5%. From the result obtained, the free fatty acid from the produced sample is 1.41 % showing that the produced oil is of high quality and within the range approved or recommended by SON, FAO and WHO and therefore not adulterated. It is therefore suitable for domestic use. However, the quality of the red palm oil sold at the open market within the area of study cannot be said to have the same quality as it may have been subjected to mishandling and storage which will inadvertently affect the FFA of the oil. Therefore, the quality of the oil sold to the end-users should be evaluated in order to ascertain the quality. It should be noted that the values obtained from this research were for a freshly produced palm oil hence the properties of the oil should be analyzed after the oil has been stored for a minimum period of three months. Finally, the effect of temperature, processing medium and processing method on the yield and quality of the oil should be investigated when freshly produced and after storage.

REFERENCES

[1] D.T. de Almeida, I.L. Nunes, P. L. Conde, R.P.S., Rosa, W.F. Rogerio and E.R Machado, "A quality assessment of crude palm oil marketed in Bahia, Brazil", *grasas y aceites,* **64 (4), 387-394, 2013.**

[2] K. Nwosu-Obieogu, F. Aguele, L. Chiemenem Linus, K. Adekunle, "Analysis on the Physicochemical Properties of Palm Oil Within Isialangwa Local Government Area of Abia State, Nigeria", *International Journal of Bioorganic Chemistry*. Vol. **2**, No. **4**, pp. **159-162, 2017.**

[3] A. R. Norizzah, M. Norsyamimi, O. Zaliha, K. Nur Azimah and M. F. Siti Hazirah, "Physicochemical properties of palm oil and palm kernel oil blend fractions after interesterification*", International Food Research Journal,* **22(4): 1390-1395, 2014**.

[4] N. H. Azeman, N. A. Yusof, and A. I. Othman, "Detection of Free Fatty Acid in Crude Palm Oil", *Asian Journal of Chemistry*, Vol 27, No. **5, 1569-1573, 2015**.

[5] A. Al-W. Japir, J. Salimon, D. Derawi, M. Bahadi, S. Al-Shuja'a and M. R. Yusop, "Physicochemical characteristics of high free fatty acid crude palm oil", OCL, **24(5), D506, 2017**

[6] O. I. Mba, M-J. Dumont and M. Ngadi, "Palm oil: Processing, characterization and utilization in the food industry – A review" *Food Bioscience* **1 0, 2 6 – 4 1, 2015**.

[7] P. Hariyadi, "Food safety & nutrition issues: challenges and opportunities for Indonesian palm oil", *IOP Conf. Series: Earth and Environmental Science* **418, 012003, 2020.**

[8] V. K. Tyagi, and A. K. Vasishtha, "Changes in the characteristics and composition of oils during deep-fat frying" *Journal of the American Oil Chemists Society,* **73(4), 499–506, 1996.**

[9] P. V. De Greyt, W. M. Kellens and A. Huyghebaert, "Physical and chemical properties of trans-free fats produced by chemical interesterification of vegetable oil blends", *J. Am. Oil. Chemists Soc*. **75(4):489-491, 1998.**

[10] F. F. Akinola, O. O. Oguntibeju , A. W. Adisa 1 and O. S. Owojuyigbe, "Physico-chemical properties of palm oil from different palm oil local factories in Nigeria", *Journal of Food, Agriculture & Environment Vol*.**8 (3& 4): 2 6 4 - 2 6 9, 2 0 1 0.**

[11] R. D. O'Brien, "Fats and oils: Formulating and processing for applications (3rded.)".Boca Raton, Florida: C R C Press **2010**.

[12] S. J. Wu and L. T. Ng, "Antioxidant and antihepatoma activities of palm oil extract", *Journal of Food Lipids,* **14, 122–137, 2007**.

[13] S. J. Wu, P. L. Lui and L. T. Ng, "Tocotrienol-rich fraction of palm oil exhibits anti-inflammatory property by suppressing the expression of inflammatory mediators in human monocytic cells", *Molecular Nutrition and Food Research,* **52, 921–929, 2008.**

[14] A. O. Adebayo-Oyetoro, T. M. Ojaomo, F. F. Akinwande and S. A. O. Adeyeye, "Assessment of Palm Oil Sold in Mainland Markets, Lagos State, Nigeria", *EC Nutrition* **14(3): 208-214, 2019.**

[15] M. K. C. Sridhar and O. O. AdeOluwa. "Palm Oil Industry Residue". Biotechnology for Agro-industrial Residues Utilisation. Nigam, P. S and Pandey, A. (eds.). Springer Science: **341-355, 2009**.

[16] Singh R., *et al*. "Mapping quantitative trait Loci (QTLs) for fatty acid composition in an interspecific cross of oil palm". *BMC Plant Biology* **9: 114, 2009.**

[17] S. E. Atawodi. "Phenolic Compounds and Antioxidant Potential of Nigerian Red Palm Oil (Elaesis guineesis)". *International Journal of Biology* **3 (2): 153-161, 2011**

[18] E. Gesteiro, L. Guijarro, F. J. Sánchez-Muniz, M delCarmen Vidal-Carou, A. Troncoso, L. Venanci, V. Jimeno , J. Quilez, A. Anadón and M. González-Gross, "Palm Oil on the Edge", *Nutrients* **11, 2008; doi:10.3390/nu11092008.**

[19] N. L. H. M. Dian; R. A. Hamid; S. Kanagaratnam; W. R. A. Isa; N. A.M. Hassim, N. H. Ismail, Z. Omar and M. M. Sahri, "Palm Oil and Palm Kernel Oil: Versatile Ingredients for Food Applications. *Journal of Oil Palm Research* Vol. **29 (4)**: **487 – 511, 2017**

[20] Y. Basiron and C. K. Weng, " The oil palm and its sustainability", *J Oil Palm Res* **16: 1–10, 2004.**

[21] Y. BASIRON, "Palm oil production through sustainable plantations" *European J. Lipid Science and Technology,* **109: 289-295, 2007**.

[22] O. B. Imoisi, G. E Ilori, I. Agho and J. O. Ekhator, "Palm Oil, its Nutritional and Health Implications (Review)", *J. Appl. Sci. Environ. Manage*. Vol. **19 (1) 127 – 133, 2005.**

[23] Y. BASIRON, "An overview of Malaysian palm oil in Global Oils and Fats Scenario", *Paper presented at the Palm Oil Trade Fair and Seminar. Cairo, Egypt*, **2015.**

[24] Y. M. CHOO, "Palm oil: a versatile ingredients for food and non-food applications", *Presented at the Malaysia-Vietnam Palm Oil Trade Fair and Seminar (POTS)* **2013**.

[25] M. T. Tarrago-trani, K. M. Phillips, L. E. Lemar, and J. M. Holden, "New and Existing Oils and Fats Used in Products with Reduced *trans*-Fatty Acid Content", *J. American Dietetic Association,* **106: 867-880, 2006**

[26] S. A. Ekop, B. A. Etuk, and N. O. Eddy, "Effect of Some Local Additives on the Chemical Constituent of Palm Oil", J. Appl. Sci. Environ., Vol.**11 (1) 85 – 89, 2007.**

[27] E. I Ohimain., *et al*. "Assessment of the quality of crude palm oil produced by small scale holder processors in River state, Nigeria". *Nigerian Journal of Agriculture, Food and Environment, 8.2***: 28-34, 2012.**

[28] E. G. F. Ngando *et al*. "Assessment of the quality of crude palm oil from smallholders in Cameroon". *Journal of Stored Products and Postharvest Research* **2.3: 52-58, 2011.**

[29] SON. "Standard Organization of Nigeria", "Standards for edible refined palm oil and its processed form", **2-5, 2000.**

[30] NIS, Nigerian Industrial Standards, "Standard for edible vegetable oil", **5-12, 1997.**

[31] E. C. Enyoh, C. E. Enyoh and C. E. Amaobi, "Quality Assessment of Palm Oil from Different Palm Oil Local Factories in Imo State, Nigeria" *WSN* **88(2): 152-167, 2017**.

[32] A. A. W. Japir, J. Salimon, D. Derawi, M. Bahadi, M. R. Yusop, b. Separation of free fatty acids from high free fatty acid crude palm oil using short-path distillation. In: The 2016 UKM FST postgraduate colloquium: Proceedings of the University Kebangsaan Malaysia, Faculty of Science and Technology 2016 Postgraduate Colloquium (Vol. **1784,** N° **1**, p. **030001**). AIPPublishing. DOI: 10.1063/1.4966739.

[33] U. N. EKWENYE, "Chemical Characteristics of Palm Oil Biodeterioration" *BIOKEMISTRI* **18(2):141-149, 2006**.

[34] G.I. Onwuka, "Food analysis and Instrumentation, theory and practice", Naphtali Print (**2005**).

[35] B. M. Siddique, A. Ahmad, M. H. Ibrahim, S. Hena, M. Rafatullahb and A. K. M. Omar, "Physico-chemical Properties of Blends of Palm Olein with Other Vegetable Oils", *grasas y aceites,* **61 (4)**, **423-429, 2010**, issn: 0017-3495doi: 10.3989/gya.010710 423

[36] O. A. Pike, "Fat Characterization in Food Analysis. 3rd Edition", Klumar Academic Publishers, pp. **227 – 246, 2003**.

[37] O. S. Falade, A. S. Adekunle, M. A. Aderogba, S. O. Atanda, C. Harwood, S. R. Adewusi, "Physicochemical Properties, Total Phenol and Tocopherol of Some Acacia Seed Oils" *J Sci Food Agri* **88: 263–268, 2008**.

[38] A. B. Hassan, M. S. Abolarin, A. Nasir, and U. Ratchel, "Investigation on the Use of Palm Olein as Lubrication Oil", *Leonardo Electronic Journal of Practices and Technologies* ISSN 1583-1078 Issue **8, 1-8, 2006**

[39] A. G. Abdulkadir, A.G. and W. L. O. Jimoh, W.L.O., "Comparative Analysis of Physico-Chemical Properties of Extracted and Collected Palm Oil and Tallow", *ChemSearch Journal* **4(2): 44 – 54, 2013**

[40] H. M. Tamzid., *et al*. "Physicochemical and Nutritional studies of Terminalia belerica roxb seed oil and seed kernel". *Journal of Biosciences* **15: 117-126, 2007.**

[41] T. Skara, M. Sivertsvik and S. Birkeland, "Production of salmon oil from filleting by-products effects of storage condition and content of 3 polyunsaturated fatty acids", *J. Food Sci.* 69:417-421, 2004.

[42] A. S. Olanrewaju and O. E. Moriyike, "Physicochemical Characteristics and the effect of packaging materials on the storage stability of selected Cucurbits oils", *Am J Food Nutr* **1: 34–37, 2013**.

[43] S. A. Alyas, A. Abdulah, and N. A. Idris, "Changes of Betacarotene Content During Heating of Red Palm Olein", *J. Oil Palm Res. (Special Issue),* pp. **99-102, 2006**.

[44] C. Agatemor, "Studies of Selected Physicochemical Properties of Fluted Pumpkin (*Telfairia occidentalis Hook F*.) Seed Oil and Tropical Almond (*Terminalia catappia L*.) Seed Oil", *Pak J Nutr* **5:306–307, 2006**.

[45] K. P. Prasanth and K. A., "Gopala Physico-chemical characteristics and nutraceutical distribution of crude palm oil and its fractions", *Grasas y Aceites* **65: 018, 2014**.

[46] U. R. Nagendran, Y. M. Unnithan, Y. M. Choo, K. Sundram, "Characteristics of Red Palm Oil, a Carotene and Vitamin E Rich Refined Oil for Food Uses", *Food and Nut. Bull*. **21(2):189-194, 2000**.

[47] D. B. Rodriguez-Amaya, "Changes in carotenoids during processing and storage of foods", *Arch. Latinoam. Nutr*. **49, 38-47, 1999.**

[48] SON, Standard Organization of Nigeria, "Standards for edible refined palm oil and its processed form", **2-5, 2002.**

[49] FAO, Food and Agricultural Organization of United Nations publications, Rome (2002).

[50] R. Li, Q. Xia, M. Tang, S. Zhao, W. Chen, X. Lei and X. Bai, " Chemical composition of Chinese palm fruit and chemical properties of the oil extracts", *African Journal of Biotechnology* Vol. **11(39),** pp. **9377-9382**, **2012.**

[51] J. Mlcek, H. Druzbikova, P. Valasek, J. Sochor, T. Jurikova, M. Borkovcova, M. Baron and S. Balla, "Assessment of Total Polar Materials in Frying Fats From Czech Restaurants", *Ital. J. Food Sci*., vol. **27: 160-165, 2015**

[52] N. K. Andrikopoulos, N. Kalogeropoulos, A. Falirea and M. N. Barbagianni, "Performance of virgin olive oil and vegetable shortening during domestic deep-frying and panfrying of potatoes", *Int. J. Food Sci. Tech.,* **37: 177-190, 2002**.

[53] G. Bansal, W. Zhou, P.J. Barlow, P.S. Joshi, H.L. Lo and Y. K. Chung, "Review of rapid tests available for measuring the quality changes in frying oils and comparison with standard methods", *Crc. Rev. Food Sci. Nutr.,* **50: 503-514, 2010.**

[54] B. Friedman, "Absorbent antioxidant provides optimum frying in restaurant and fast food fryers" *Eur. J. Lipid Sci. Tech.,* **102: 560-565, 2000**.

[55] U. Bracco, A. Dieffenbacher and L. Kolarovic, "Frying performance of palm oil liquid fractions", *J. Am. Oil Chem. Soc*., **58: 6-12, 1981**.

[56] K. G Berger, "The use of palm oil in frying: Frying oil series", *Malaysian Palm Oil Promotion Council (MPOPC),* **2005.** Available at http://www.mpoc.org

[57] **S.** Marmesat, A. Morales, J. Velasco and M. C. Dobarganes, "Influence of Fatty Acid Composition on Chemical Changes in Blends of Sunflower Oils During Thermoxidation and Frying", *Food Chem.* **135, 2333-2339, 2012.**

[58] L. M. Plessis and A. J. Meredith, "Palm olein quality parameter changes during industrial production of potato chips", *J. Am. Oil Chem. Soc.* **76, 731-738, 1999**.

[59] A. H. A. E. Tarmizi and R. Ismail, "Comparison of the frying stability of standard palm olein and special quality palm olein", *J. Am. Oil Chem. Soc.* **85, 3, 245-251, 2008**.

[60] R. Ismail, "Palm oil and palm olein frying applications", *Asian Pac. J. Clin. Nutr.* **4, 414-419, 2005.**

[61] E. Fokou , M. Achu, G. Kansci G, et al. "Chemical Properties of Some Cucurbitaceae Oils from Cameroon", Pak J Nutr **8: 1325–1334, 2009**.

[62] WHO, World Health Organization, WHO Technical Report**, 916: 82-88, 2003.**

[63] G. F. N. Ebonguea, R. Dhouibc, F. Carrièrec, P. H. Amvam Zollob and V. Arondelc, "Assaying lipase activity from oil palm fruit (*Elaeis guineensis* Jacq.) mesocarp", *Plant Physiol. Bioch. 44,* **611–617, 2006**.

[64] N. E. G. Frank, M. M. E, Albert and D. Ekwe, "Assessment of the quality of crude palm oil from smallholders in Cameroon", *J. Stored Prod. Postharvest Res.* **2, 52-58, 2011.**

[65] N. A. Idris, A. Abdullah and A. H. Halim, "Evaluation of palm oil quality: Correlating sensory with chemical analyses", *J. Am. Oil Chem. Soc*. **69, 272-275, 1992**.

[66] R. O. Akinyeyea, E. I. Adeyeye, O. Fasakina, A. Agboolaa, "Physicochemical properties and anti-nutritional factors of palm fruit products (Elaeis Guineensis Jacq.) from Ekiti State Nigeria", *Electr J Environ Agri Food Chem* **10: 2190–2198, 2011**.

[67] K. Y. You, A. Zulkifly and K. Khalid, "Application of microwave moisture sensor for determination of oil palm fruit ripeness", *Measurement Science Review,* Vol. **10,** pp. **7-14. 2010.**

[68] P. O. Agbaire and O. O. Emoyan, "Nutritional and antinutritional levels of some local vegetables from Delta State, Nigeria", *African Journal of Food Science* **6(1): 8-11, 2012**.

[69] K. Y. You, Z. Abbas, L. L. You, K. Y. Lee and E. M. Cheng, "Palm Oil Moisture Monitoring Based On Dielectric Properties At Microwave Frequencies", *International Journal of Microwave and Optical Technology,* Volume **9** No. **4, 2014**.

[70] M. U. Orji and T. I. Mbata, "Microbial quality and chemical characteristics of palm oil sold within Jos Metropolis, Plateau, Nigeria". *African Journal of Biochemistry Research* **2.9: 192-196, 2008**.

AUTHORS PROFILE

Mr. R. E. Nnam, is a graduate of Chemical Engineering from the Federal University of Technology, Owerri, Imo State Nigeria in year 2011. He is at present, a faculty member of the Department of Food Technology, Akanu Ibiam Federal Polytechnic, Unwana Ebonyi State Nigeria from 2015. He is a passionate researcher and has devoted his time into researching on various aspects of Food Engineering and chemical engineering processes. He has several academic publications in reputable peer-reviewed journals and a sought after in conferences. He is happily married with his heartthrob – Sweet! The union is blessed with a beautiful daughter- Ijeoma. His main research work focuses on Materials development, Chemical processes, Process engineering, clean technologies and renewable energy, Biomedical engineering.

Mr. V. O. Obinna is a faculty member of the Department of Food Technology of Akanu Ibiam Federal Polytechnic, Unwana Ebonyi State Nigeria. He joined the services of the Polytechnic as Technologist II in 2006 and rose to the rank of Lecturer I in the same Department in 2019. He has an MSc in Food Science, Safety and Health from Heriot Watt University Edinburgh, UK. He has many peer reviewed publications within and outside Nigeria to his credit. He is a well sought speaker at conferences. His research focuses are on optimization of locally available food materials, Microbiology and Safety of Foods.

Miss. Emerenini N. J. pursed Bachelor of Science degree from Abia State University Abia State, Nigeria in year 2011. She is currently working as a Lecturer in the Department of Food Technology, Akanu Ibiam Federal Polytechnic, Unwana Ebonyi State Nigeria from 2015. She has published maany works in reputable international journals and presented papers in conferences.

Mrs. Okoro N. U. pursed Bachelor of Science degree from Enugu State University of Science and technology Enugu, Nigeria in year 2002. She is currently working as a Lecturer in the Department of Food Technology, Akanu Ibiam Federal Polytechnic, Unwana Ebonyi State Nigeria from 2015. She has published maany works in reputable international journals and presented papers in conferences.

