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Physio-Chemical Analysis of Palm Oils (*Elaeis Guineensis*), Obtained from Major Markets in Agbarho, Unenurhie, Opete, Ughelli and Evwreni Town, Delta State, Nigeria

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ABSTRACT

Physichochemical analysis of palm oil purchased from major markets in agbarho, ewhreni, Opete, Ughelli and Unenurhie in Delta state, Nigeria was carried out to determine the level of adulteration and compared with Standard Organization of Nigeria (SON) for palm oil. Saponification value and peroxide, the pearson's method was adopted, moisture content was determined using the gravimetric method of air- oven drying to constant weight at 105^{o}C, free fatty acid**:** method of analysis of the association of analytical chemist was used. Iodine value by Wijs' method. Specific gravity was determined using a pycrometer gravimetric method. Viscosity was analyzed by means of Fungilab smart series Rotational Viscometer Version 1.2 at a temperature of 400C by means of a Thermostat. Melting point and Protein content, method of American oil analytical chemist AOCSCc 3-25 method. The analysis of the results obtained showed that the palm oil samples from Unenurhie had the lowest moisture content value of 0.41 %.None of the sample fell within SON recommended value of 195-205mg/g, these indicating its suitability for soap making. Though, the level of conformity of Unenurhie sample to SON standard was the closest, other samples were still close. Thus, there is likelihood that most of oil sold in the above named markets is not adulterated.

KEYWORDS: *Palm Oil, Adulteration, SON, Physio-cochemical Properties, Analysis*

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1. INRODUCTION

Palm oil with the biological name *Elaeisguineensis*, primarily known as the african oil palm is edible plant oil which is derived from the pulp of its fruit. The oil palm fruit, a prolate spherical i.e cyclic in shape varies between 15 and 40 mm in length and could be as large as 30 mm in diameter is found mainly in bunches that are attached to the crown of the palm tree through a means of stalk. Palm oil tree takes from 2-3 years to start producing matured fruit. It is a perennial plant (i.e it takes more than two years to mature). It can produce fruit continuously for 25years or more. Palm oil fruit is a yellowish-red in colour. There are several species in the arecaceae family, the family of the palm (Rich, 2008). Palm oil consists of a high amount of beta-carotene that is why it is naturally yellowish red in colour. Palm oil contains several saturated and unsaturated fats in its seed, in the forms of palmitate (saturated), glyceryllaurate (saturated), stearate (saturated), oleate (monosaturated), linoleate (polyunsaturated), myristate (saturated) and linolenate (polyunsaturated). Palm oil is made up of pericarp which is made up of three layers, namely the exocarp (i.e the skin), mesocarp (known as the outer pulp containing palm oil) and endocarp (i.e the hard shellen closing the kernel). The endosperm contains carbohydrate and oil reserves for the embryo. The importance, quality and uses of palm oil in our diet cannot be measured. It is one of the main sources of vegetable oil, consumed in the world as a whole today, accounting for 35% of all oils consumed globally.

Like all other oils, triglycerides are the main constituents of palm oil. Moreover, more than 95% of palm oil consists of mixtures of triglycerides (glycerol molecules), each contain or esterified with three fatty acids. During the extraction of oil from its mesocarp, the hydrophobic triglycerides attract other fats or oil-soluble cellular components which represent the minor (i.e small) components of palm oil such as tocopherols, phosphatides, sterols, pigments, tocotrienols and trace metals. However, other components of palm oil include monoglycerols, free fatty acids and diglycerols. The fatty acids are any of the class of aliphatic acids such as palmitic, oleic and stearic found both in animal and vegetable fats and oils. The major fatty acids in palm oil are palmitic, myristic, stearic, oleic and linoleic. Thus, most of the fatty acids are present as triglycerides. It has been reported that palm oil contain both saturated and unsaturated fatty acids in approximately 6%. The minor constituents can be classified into two groups. The first group consists of fatty acid derivatives, such as partial glycerides (e.g monoglycerols), esters phosphatides, and sterols while the second group consists of compounds not related chemically to fatty acids and they are usually the

hydrocarbons, free sterols, aliphatic alcohols, tocopherols, pigments and trace metals. Most of the minor (i.e small) components found in the unsaponifiable fraction of oil palm are sterols, pigments, higher aliphatic alcohols, and hydrocarbons. Moreover, the other minor components such as partial glycerides and phosphatides are saponifiable by basic hydroxide. The partial glycerides do not occur naturally in significant amounts except in oil palm from damaged (spoilt) fruits and such oils would have undergone partial hydrolysis resulting in the production of free fatty acids, partial glycerides and water.

However, over 90% of the world oil production is mainly used as food. Recently, there has been wide spread speculations that palm oil quality is adulterated (i.e mixed with low costa chemicals) in order to increase profit margin. With the sudden rise in cases of heart diseases, cancer, and organ damages, it has become imperative for Nigerians to pay attention on the quality of palm oil bought to be used in their diets considering the current adulterated trend, producers and marketers add inedible medium poisonous substances or chemicals that could make palm oil appear like the unadulterated one. However, sometimes it has been observed that edible palm oil fall short of the recommended quality standards that is considered safe for consumption due to the adulteration. The low quality could be as a result of the presence of some inclusion which has been added intentionally by the producers (i.e manufacturers) or marketers to enhance quantity, viscosity, appearance, etc. it is called adulteration and it is a dangerous practice to human health. The expertise and techniques put to use in this process has made it practically almost impossible to physically differentiate between a good palm oil and the adulterated one, hence consumers look for redness or quality appearance before buying their palm oil. Moreover, that is one major attribute or quality of the palm oil; this situation arose because local production can no longer satisfy the fast growing population demand. Hence, it is therefore important to analyze the physico-chemical properties of palm oil for sapanification value, protein content, free-acid value, ester value, iodine value, , peroxide value, specific gravity, moisture content, viscosity, amino acid and melting point at different temperatures that is consumed by the local communities inhabitants. **Saponification value** is the amount of alkali or basic necessary to saponify a definite quantity of the sample (i.e oil). It is expressed as the number of milligrams (mg) of potassium hydroxide (KOH) required for saponifying 1 g of the sample (oil). The smaller the saponification number is, the larger or bigger the average molecular weight of the tricylglycerol present in the sample of oil. **Acid value and free acid content** is the number of milligrams (mg) of the potassium hydroxide (KOH) necessary to neutralize the free acid in 1 g sample of the oil. Thus, the acid value is often a good measure of the breakdown of the triacylglycerol into free fatty acids, which also has an adverse effect on the quality of many fats produced. **Iodine value**: iodine value of oil or fat is defined as the weight of iodine absorbed by 100 g of the oil or fat. The glycerides of the unsaturated fatty acids (particularly of the oleic acid series) unite with a definite amount of the group vii elements i.e the halogen and the iodine value is therefore a measure of the degree of unsaturation. It is consistent for particular oil or fat, however, the exact figure obtained depends on the particular technique or the expertise employed. However, the higher the degree of unsaturation (higher iodine value), the greater the likelihoods that the oil will become rancid by oxidation. **Peroxide value** is the measure of the degree of oxidation of the oil. The peroxide value determines the extent to which the oil has undergone rancidity. **Viscosity** can be defined as the resistance of lipid i.e fats and oil to flow. Viscosity increases with increase in molecular weight but decreases with increasing unsaturated level and temperature (Nouredini *et al.,* 1992). **Specific gravity** can be defined as the ratio of the mass of a given volume to the mass of equal volume water. The specific gravity decreases with increased temperature and decreases slightly as viscosity decreases for similar composition (Akinola *et al*., 2010). **Ester value** is calculated or obtained by finding the difference between the saponification value and the acid value. This study was aimed at determining the physico-chemical properties of palm oil obtained from major markets in agbarho, ewhreni, Opete, Ughelli and Unenurhie in Delta state, Nigeria.

2. Materials and Methods

2.1. Materials*:*

Samples of palm oil were purchased from five different markets in delta state namely: Agbarho, Ughelli, Unenurhie, Opete and Ewhreni market repectively. The samples were collected in a nylon bag and properly tied. The samples were taken to the laboratory for immediate analysis. All the reagents used were of analytical grade made by British Drug House (BDH) Poole England. Fatty acid methyl esters and triacylglycerol standards were obtained from Sigma Chemical Company, USA.

Reagents: 0.1M alcoholic potassium hydroxide solution, 1% phenolphthalein indicator, 0.5M alcoholic potassium hydroxide solution, 0.1 M Na2S2O3.5H20 (sodium thiosulphate) , 0.2 N HCl, 40% NaOH solution, 0.5M HCl solution solution, 10% potassium iodide,KI, 44% H3BO3, Kjedahl catalyst solution, mixed indicator, 1% starch solution, Wij's solution.

2.2. Methods

Analysis of saponification value: The pearson's method was adopted. 3g of oil was weighed accurately and put into a conical flask containing 25 mL of 0.5 M alcoholic KOH. Reflux condenser was fitted to the flask containing the ionic solution and heated in a water bath for an hour swirling the flask frequently. Excess KOH was titrated hot with 0.5 M HCI using 1 mL of phenolphthalein (1%) solution. The saponification value was calculated from the difference between the blank and the sample titration. Saponification value is calculated as:

$$S.V = \frac{(b - a) \times 28.05}{g \text{ (weight of sample)}}$$

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.

Analysis of free fatty acid: method of analysis of the association of analytical chemist was used. 2g of the oil sample was dissolved in 50 ml of neutral solvent (25 ml of Diethylether and 25 ml of 95% ethanol) in a conical flask, 2-3 drops of phenolphthalein indicator were added and the solution was titrated with 0.1 M alcoholic KOH until a pink colour was obtained. The result was calculated using:

$$\% \text{ free fatty acid} = \frac{T \times 282}{1000 \times 10g} \times 100$$

Where T = Titre value of alcoholic KOH used, 282 = molecular of oleic acid.

Analysis of acid value: Two g of oil was dissolved in Ten ml of diethyl ether and 10 ml of n-propanol were mixed and 1 mL of phenolphthalein solution (1%) was added and titrated with aqueous 0.1 M KOH, shaking constantly until a pink colour which persists for 15 s was obtained. The amount of KOH used was recorded. The procedure was repeated for the blank.

$$\text{Acid value} = \frac{\text{Titre value}}{\text{g (Weight of sample used)}} \times 5.61$$

Analysis of peroxide value: the pearson's method was adopted for the analysis of peroxide value. 2g of oil sample was weighed and poured into a dry 250 mL stoppered conical flask, flushed with inert gas. 10 mL of chloroform was added and the oil was dissolved by swirling. 15 ml of glacial acetic acid and 1 mL of fresh saturated aqueous potassium iodide solution were added. The flask was stoppered, shaken for 1 min and placed for 1 min in the dark. Thereafter 75 mL of water was added, mixed and the freed iodine was titrated with 0.002 M sodium thiosulphate solution using soluble starch solution (1%) as an indicator. The titre value was recorded as V. Blank determination (Vo) was also recorded.

$$\text{P. V} = \frac{(V - Vo)\ T \times 103}{M} \text{ mEq/kg}$$

Where:
T = exact molarity of sodium thiosulphate solution.

Analysis of iodine value: The iodine value was determined by Wijs' method. Palm oil was added and suitably weighed in a dry glass– stoppered bottle. The appropriate weight in gram of the palm oil to be used was calculated by dividing 20 by the highest expected iodine value, the stopper was inserted (previously moistened with potassium iodide solution) and allowed to stand in the dark for 30 min. Of potassium iodide (10%) 15 mL was added and mixed with 100 mL water. The solution was titrated with 0.1 mL thiosulphate solution using starch indicator just before the endpoint (titration = q mL). Blank was treated at the same time commencing with 100 mL of carbon tetrachloride (titration = v mL).

$$\text{Iodine value} = \frac{(v - q)}{\text{g (Weight of sample)}} \times 1.269$$

Analysis of moisture content: Moisture content was determined using the gravimetric method of air- oven drying to constant weight at 105oC. A dry clean crucible was weighed (W_1), 5g of the sample was placed in the crucible to give weight (W_2), it was placed in an acid dry oven at 150°C for 4 hrs. The moisture content was calculated as:

$$\text{Moisture content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where:
W_2 = weight of sample + crucible
W_3 = weight after drying
W_1 = weight of the empty crucible

Specific gravity: The specific gravity was determined using a pycrometer gravimetric method. 10 ml of distilled water was weighed on weighing balance and the weight was recorded as W_1. Ten ml of the oil sample was also weighed on the weighing balance and the weight was recorded as W_2.

$$\text{Specific gravity} = \frac{W_2}{W_1}$$

Where:
W_1 = weight of distilled water
W_2 = weight of the oil sample.

Analysis of ester value: Ester value is obtained by finding the difference between the saponification value (SV) and acid value (AV). That is,
Ester value = Saponification value – acid value

Analysis of viscosity: the viscosity was analyzed by means of Fungilab smart series Rotational Viscometer Version 1.2 at a temperature of 40°C by means of a Thermostat. The viscometer was properly fastened to the stick and level, the appropriate spindle was selected. The oil was contained in a 250 cm^3 beaker and maintained at a temperature of 40°C by the means of a thermostat while the selected spindle was carefully fastened to the viscometer's axle and submerged into the oil to the halfway mark on the axle. The viscosity was turned on and the reading was taken.

Analysis of melting point: the melting point was determined using AOCSCc 3-25 (AOCS, 1989) method. Capillary tubes were inserted into the blended oil samples to obtain a 10±2 mm long column of oil samples, the capillary tubes were then sealed at one end using a Bunsen flame. The capillary tubes with the oil samples were kept in a refrigerator for three days during which the oil became solidified. With the help of a thread, the capillary tube with the sample was tie to a thermometer and inserted into a water bath at 30oc. The temperature at which the oil began to rise up in the tube was recorded as the melting point.

Analysis of protein content: the method of American oil analytical chemist (AOAC, 2000), was used. 2g of the sample was weighed into the digestion flask containing 200 mL of concentrated H_2SO_4 acid, 5kg Kjedahl catalyst was added and the flask placed in an inclined position heating gently until frothing ceases. It was boiled until solutions clears. The solution was cooled and 60 mL of distilled water was cautiously. The flask was immediately connected to digestion bulb on condenser and with tip condenser of immersed in standard and 5-7 drops of mixed indicator in receiver. The flask was rotated to mix content thoroughly then heated until all NH_3 is distilled, the receiver was removed; the tip of the condenser washed and the distilled standard excess acid titrated with standard NaOH solution. The protein content is calculated as follows:

$$\text{Protein (\%)} = \frac{(A-B) \times N\ 14.007 \times 6.25}{W}$$

Where:
A = volume (mL) of 0.2 N HCl used sample titration
B = volume (mL) of 0.2 N HCl used in blank titration
N = Normality of HCl
W = weight (g) of sample
14.007 = atomic weight of Nitrogen
6.25 = protein-nitrogen conversion factor for fish and its by-product.

3. Results and Discussions

Table1. Physiochemical Properties of Palm Oil from five Major Markets

Samples Parameters	AGBM	UGHM	OPM	EWRM	UNURM	SON STANDARD
Acid Value(mgKOH/g)	1649.7	1731.6	2745.3	2191.2	2657.2	
Ester Value(mgKOH/g)	1521.9	1654.9	2387.4	529.3	816.3	
Specific Gravity (g/cm^3)	0.99	0.96	0.94	0.97	0.96	0.897-0.907
Free Fatty Acid(%)	23.4	34.7	32.7	54.7	82.1	3.5
Iodine value(mg/L)	-	-	-	-	-	4.5-5.3
Melting Point(^{0}C)	84	82	80	87	86	
Moisture Content(%)	0.56	0.62	0.98	0.96	0.41	0.29
Peroxide Value(mg/g)	10.2	17.1	17.9	21.6	11.9	10
Protein content(%N_2)	-	-	-	-	-	
Saponification Value(mg/g)	127.8	76.7	357.9	1661.9	1840.9	195-205
Viscosity (mPa.S)	64.6	95.1	73.6	80.5	137.4	

AGBM=Agbarho market, UGHM=Ughelli market, OPM= Opete market, EWRM=Evwreni market and UNURM= Unenurhie market.

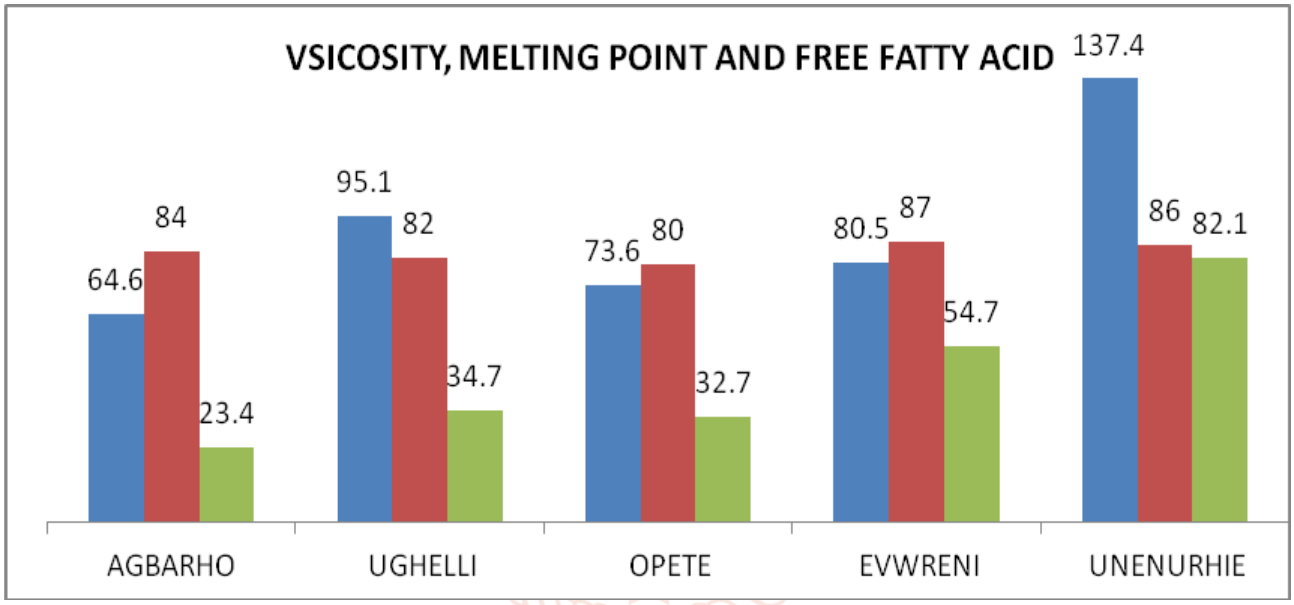

Figure1. Viscosity, Melting Point and Free Fatty Acid Value of Palm oil from five Major Markets in Delta State

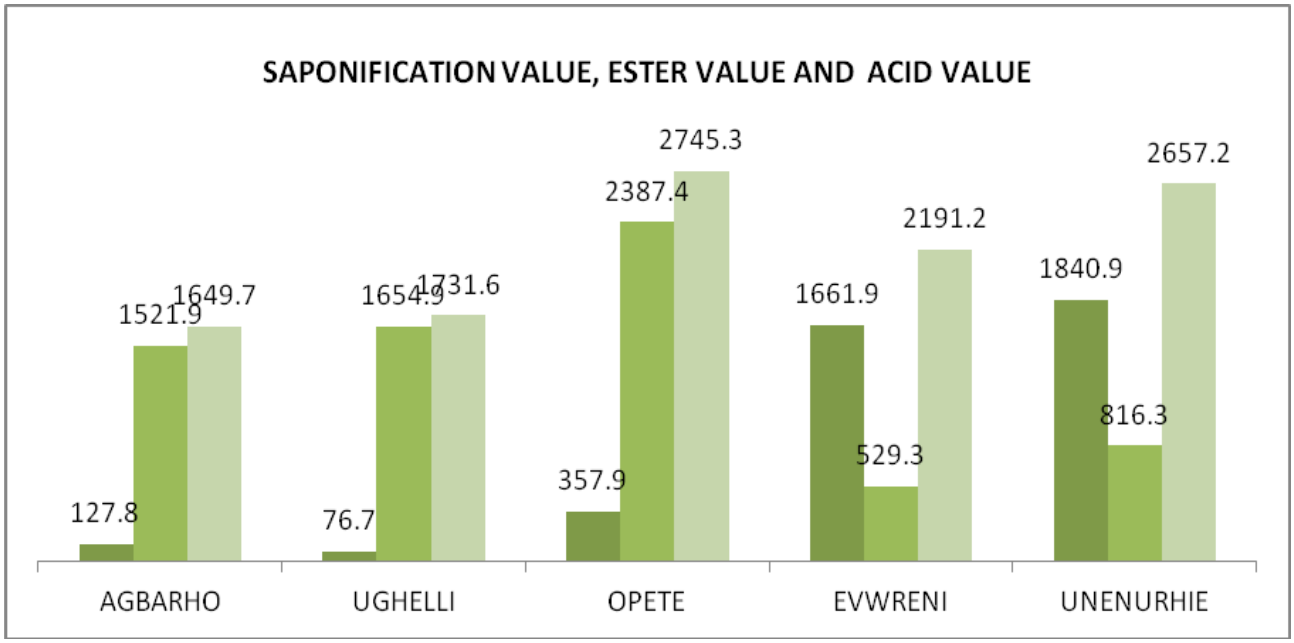

Figure2. Saponification Value, Ester Value and Acid Value of palm oil from Five Major Markets in Delta State

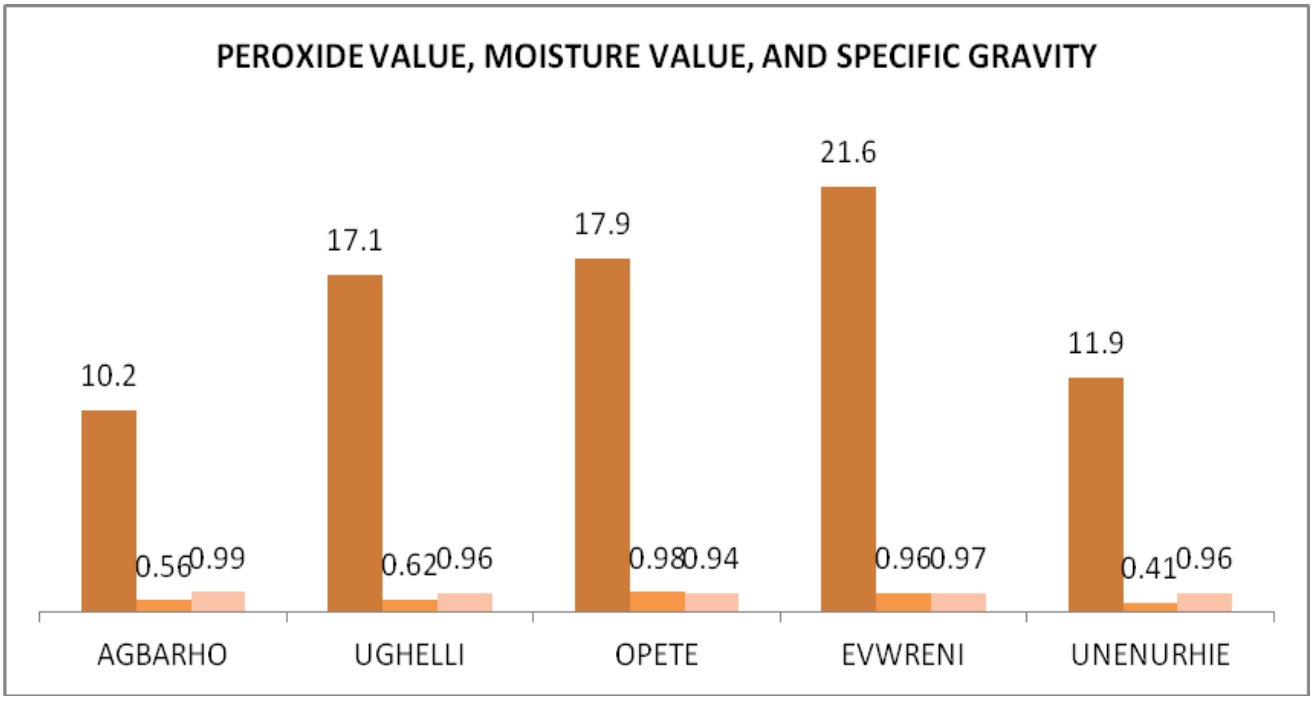

Figure3. Peroxide Value, Moisture Value, and Specific Gravity values of palm oil from Five Major Markets in Delta State

Discussion

The high saponification value indicates that palm oils are normal triglycerides and very useful in production of soup and shampoo. The low moisture content of the palm oil from Unenurhie indicates that its storage stability is better than the other samples, although they all fell within the range of recommended value of 0.29 percent. For specific gravity, all the samples were within the recommended range of palm oil parameters. Agbarho has the lowest free fatty acid value which indicates that it is very good for human consumption and they are not prepared from rotten palm fruits. Recommended peroxide value is minimum 10 mg/g. Peroxide value determines the extent to which the oil has undergone rancidity, hence all the samples were within recommended value of 10mg/g. For saponification values, none of the sample fell within the Standard Organization of Nigeria (SON) recommended value of 195-205mg/g, these indicating its suitability for soap making.

4. Conclusion

This study showed that palm oil produced and sold at different markets in Delta State, in the Southern Nigeria display varieties of physico-chemical properties which tend to reflect the stability and quality of the palm oil. From the analysis carried out, it could be observed that the palm oil sample from Unenurhie market/community had the best physicochemical property that fell within SON standard, although other samples still had properties within the standard. Therefore, it is easy to conclude that the palm oil samples studied were not adulterated and that the processing and storage methods employed were adequate, hence its suitability for both domestic, commercial and industrial purposes.

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