

**ASSESSMENT OF THE QUALITY OF CRUDE PALM OIL FROM *ELAEIS GUINEENSIS*  
GROWING AREAS OF THE  
PT. LANGKAT NUSANTARA KEPONG-PTPN II NORTH SUMATERA**

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**ABSTRACT**

*Palm oil is one of the major fats and oils produced in Indonesia, which is of great value in the diet of many people. The quality of palm oil could be affected by various factors ranging from improper postharvest handling, processing and storage. Recently, there has been wide spread speculation that palm oil is adulterated in order to maximize profit (Madubuike et al., 2015). The quality parameters of palm oil are generally determined by the moisture content, impurity, specific gravity, percentage of free fatty acid (FFA), iodine value, peroxide value and saponification values. The objective of this research therefore was to evaluate the quality of palm oil samples obtained from elaeis guineensis growing areas of the PT. Langkat Nusantara Kepong-PTPN II North Sumatera. The results showed that mean value of the quality parameters are 0.15% moisture content; 5.71% impurity level; 0.935 specific gravity; 8.43% FFA; 52.13 iodine value; 13.71 meq/kg peroxide value; and 181,89 mg KOH/g saponification value. The quality parameters are associated with the method of processing.*

**Keywords:** *Moisture Content, Impurity, Specific Gravity, Percentage Of Free Fatty Acid, Iodine Value, Peroxide Value And Saponification Values.*

**A. Introduction**

Palm oil plant is the highest oil producing plant (Ngando et al., 2011; Madubuike et al., 2015) with an average yield of 3.5 tons of oil/ha/year of which has an increasing consumer interest in tropical West. Since 2006, palm oil has become the world's most important edible oil with about 37 million tons produced that year, representing 25% of the total oils and fats production (Oil world Ista GmbH Mielke, 2007).

Extracted from the mess carp of the fruit, crude palm oil (usually referred to as CPO) represents 95% of the total oil production of the oil palm which also provides palm kernel oil. The fruit reddish and each fruit is made up of an oily, fleshy outer layer (pericarp), with a single seed and palm kernel oil from the seeds both of which are important in the world trade. Palm oil contains approximately 50% saturated fats and 40% unsaturated fat. Meanwhile, the light yellow to orange red of palm oil is due to the in fat soluble carotenoids in terms of retinol which are responsible for the high Vitamin A content (Vaughan, 1990., May, 1994., Ugwu et al., 2002). Industrially, palm oil could be refined to give a light product which could be used in the manufacturing of margarine, biscuits, ice-cream, shortenings, cooking fats as well as cooking oils (Lewkowitsch, 1992; Madubuike et al., 2015).

The quality of palm oil could be affected by various factors ranging from improper postharvest handling, processing and storage. Recently, there has been wide spread

speculation that palm oil is adulterated in order to maximize profit (Madubuike et al., 2015). The quality of palm oil is generally determined by the moisture content, impurity, specific gravity, percentage of free fatty acid (FFA), iodine value, peroxide value and saponification values (Tagoe et al., 2012; Madubuike et al., 2015). Palm oil is one of the major fats and oils produced in Indonesia, which is of great value in the diet of many people. The objective of this research therefore was to evaluate the quality of palm oil samples obtained from *elaeis guineensis* growing areas of the PT. Langkat Nusantara Kepong-PTPN II North Sumatera.

**B. Materials and Methods**

**Field sampling**

The palm oil samples used for this work is one 750 ml bottle of CPO purchased from *elaeis guineensis* growing areas of the PT. Langkat Nusantara Kepong-PTPN II North Sumatera and taken to the storage of CPO in laboratory for analyses.

**Moisture Content Determination**

Gravimetric method was used for moisture determination. Five (5) g of sample was weighed into evaporation dish. It was placed in an oven and maintained at 105°C for 3 hours intervals. After drying to a constant weight, the samples were cooled in a desiccator and re-weighed using analytical balance.

$$\% \text{ Moisture} = \frac{b - c \times 100}{b - a}$$

Where b = weight of crucible and sample

c = weight of crucible and dried oil

a = weight of crucible only.

(Ohimain et al.,2013).

**Impurity Determination**

The impurities were determined after dissolving the oil in petroleum ether, followed by filtration and sock let extraction before oven drying to a constant weight (Aletor et al., 1990). Ten (10) g of sample was weighed into the beaker. It was heated at 105°C and filtered while hot. The filtered sample was allowed cooled in a desiccator and weighed. The residue obtained was calculated as the percentage impurity (Ohimain et al.,2013).

**Specific Gravity Determination**

Specific gravity bottles were used to determine the specific gravity of all samples. The specific gravity bottles with glass stoppers were filled to the brim over flowing with the CPO samples. All spillages on the body of the bottle were cleaned after the bottle has been with the glass stopper. Then the specific gravity bottle is weighed on an analytical weighing balance (Metler Toledo) and specific gravity is determined.

$$\text{Specific gravity} = \frac{\text{Mass of SG Bottle+Sample}}{\text{Weight of SG}}$$

(Ohimain et al, 2013).

**Free Fatty Acids And Acid Values Determination**

The FFA concentration was determined by titrating the alcoholic solution of the oils with an aqueous solution of sodium hydroxide using phenolphthalein indicator (Aletor et al., 1990). About 10g of the oil was weighed into the conical flask. Fifty ml of alcohol ether mixture in equal volume was added and it was warmed in a laboratory hotplate stirrer to obtain a homogeneous mixture. 1ml of phenolphthalein indicator was then added and was filtrated with 0.1 M Na OH until a fairly pink end point was obtained.

$$\% \text{ FFA as palmitic acid} = \frac{\text{ml of Na OH} \times \text{Molarity} \times 28,2 \text{ mg}}{\text{Weight of sample}}$$

(Ohimain et al.,2013).

**Iodine Value Determination**

The iodine value was determined by the Wijs' method using the guide provided by Pike (2003). A moderate mixture of iodine monochloride and acetic acid were added to the CPO samples. The mixture was allowed to stand for 30 minutes in dark. About 15ml of 10% potassium iodide was added to the mixture (Akinola et al., 2010). The solution was titrated with 0.1ml sodium thiosulphate solution using starch indicator to a colorless end point (S). Analysis of Blank (B) was also carried out. Therefore;

$$\text{Iodine value} = \frac{(B-S) \times N \times 12,69}{\text{Sample Weight (g)}}$$

Where, B = blank titter value;  
S = sample titter value;

N = normality of sodium thiosulphate solution; 12.69 is used to convert from meq thiosulphate to g iodine; molecular weight of iodine = 126.9 (Ohimain et al.,2013).

**Peroxide Value determination**

The peroxide value was determined by titrating chloroform/glacial acetic acid/potassium iodide solution of the oil with an aqueous solution of sodium thiosulphate using starch as indicator (Aletor et al., 1990). About 5g of oil was weighed into the 250ml conical flask. A mixture of glacial acetic acid and tri chloromethane chloroform (30ml) was added in a ratio of 3: 2. About 0.5ml of saturated potassium iodide solution was also added. The mixture was properly shaken. 30ml of water was added. The solution was filtrated with 0.01M sodium thiosulphate, while slowly adding the titrant with a continuous shaking until a yellow color is shown. About 5ml of starch indicator was added to the titration process while shaking vigorously until a blue-black color is discharged. A blank sample devoid of CPO was also analyzed using the same procedure. The peroxide value is expressed mathematically as follows:

$$\text{Peroxide value (meq Peroxide/kg)} = \frac{(S-B) \times M \times 1000}{\text{Sample Weight}}$$

Sample weight

Where S = Sample titer

B = Blank

M = Molarity of sodium thiosulphate.

(Ohimain et al.,2013).

**Saponification Value Determination**

The saponification value was determined using the guide provided by Pike (2003). About 2g of CPO were weight into excess 0.5M alcoholic KOH of about 25ml (Akinola et al., 2010). Heat was applied while swirling to saponification the fat. The treated CPO samples were titrated with 0.5 M H Cl 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; 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

(Ohimain et al.,2013).

**C. Result And Discussion**

The results showed that the mean value are 0.15% moisture content; 5.71% impurity level; 0.935 specific gravity; 8.43% FFA; 52.13 iodine value; 13.71meq/kg peroxide value; and

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181,89 mg KOH/g saponification value. These parameters were used in this study to assess the quality of palm oil from *elaeis guineensis* growing areas of the PT. Langkat Kepong-PTPN II North Sumatera.

The moisture content of the CPO (0.15 %) were slightly higher than the recommended limits of 0.10% (Aletor et al. 1990). The value from this study were lower than previous studies irrespective of the method of processing (i.e. mechanized and or traditional) and source of CPO (i.e. mills or market) (Akubor and Ogu, 2012; Aletor et al., 1990; Ohimain et al., 2012a; Okechalu et al., 2011; Onwuka and Akaerue, 2006; Enemuor et al., 2012).

Ngando et al (2011) also reported that the moisture content of CPO produced in Cameroun are 0.22%, 0.23 0.32% and 0.08% for traditional, semi-mechanical and mechanized method of processing respectively. Zu et al. (2012) reported the moisture content of CPO produced in Ghana as 0.79 – 1.59%. Udensi and Iroegbu (2007) reported 0.14 – 0.60% as the moisture content of CPO sold in major market of Abia state. Agbaire (2012) reported 0.14 – 0.17% as the moisture content of CPO sold in Delta state. High moisture content is an indication of ease of spoilage and rancidity as well as short shelf- life (Agbaire, 2012). The low moisture content obtained from this study show the storage stability of the CPO (Ohimain et al.,2013).

The level of impurities in the CPO (5.71%) was higher than the recommended limits of 0.01% (Ngando *et al.*, 2011; Aletor et al., 1990), also the value reported in this study is higher than previous studies (Ohimain et al., 2012a; Onwuka and Akaerue, 2006) apart from (Akubor and Ogu, 2012). Ngando et al. (2011) reported the impurity level of CPO produced in Cameroun as 0.11%, 0.05 – 0.31% and 0.01% for traditionally, semi-mechanically and mechanized method of processing respectively. Zu et al. (2012) reported 0.10 – 0.13% as the impurity level of CPO produced traditionally in Ghana. The high impurity level obtained from this study could be associated with the methods of extraction (Poku, 2002; Ohimain et al., 2012a; Ohimain et al.,2013).

The specific gravity value of this study (0,935) is higher than previous studies (Akinola et al., 2010; Onwuka and Akaerue, 2006). Udensi and Iroegbu (2007) reported 0.832 – 0.880 as the specific gravity of CPO sold in major markets of Abia state, Nigeria. Agbaire (2012) reported 0.859 –0.885 as the specific gravity of CPO sold in major markets of Delta state. The specific gravity of the CPO showed that it's less dense than water, and so will float.

Hence they are not neutrally buoyant in water (Ohimain et al.,2013).

The FFA result of this study is comparable to previous report of CPO from traditional method of processing (Ohimain et al., 2012a; Aletor et al., 1990), also Amata and Ozuor (2013) reported % FFA of CPO produced from Delta North via different processing methods as 15.1 – 17.6% (traditional), 12.80 – 15.40% (semi- mechanized) and 11.27 – 12.53% (mechanized). Ngando et al (2011) reported % FFA of CPO produced by semi- mechanized approach in Cameroun as 5.00 – 10.26% whereas traditional and mechanized approach were 6.39 and 4.71% respectively. Zu et al. (2012) reported % FFA of 13.77 – 18.67 in Ghana which is higher than the result of this study. The result of this study is also different that of other authors (Akubor and Ogu, 2012; Akinola et al., 2010; Okechalu et al., 2011; Onwuka and Akaerue, 2006; Enemuor et al., 2012). The CPO produced by semi mechanized mill in Bayelsa state could be regarded as hard oil because their FFA content is greater than 5% (Hyman 1990; Ohimain et al., 2012a), therefore the high FFA reported in this study could be attributed to the level of exposure to sunlight (Ohimain et al.,2013).

The iodine value of CPO from this study (52.13) is far from previous studies (Okechalu et al., 2011; Akinola et al., 2010; Onwuka and Akaerue, 2006; Akubor and Ogu, 2012). But comparable to Udensi and Iroegbu (2007) that reported 52.61 – 53.48 as the iodine value of CPO sold in major market of Abia state, Nigeria. Iodine value is the quantity of iodine absorbed by one gram of the oil to saturate the sigma bond. It is an indication of the level of unsaturation and susceptibility of oil to oxidation and rancidity (Agbaire, 2012). Iodine value determines the stability and shelf life of oil. High iodine value makes the oil to be unstable thereby influencing other downstream application beside food (Ohimain et al.,2013).

The peroxide value recorded in this study (13.7meq/kg) was higher than the10 meqO<sub>2</sub>/kg limit recommended by World Health Organization (WHO) (Ngando et al., 2011). Aletor et al. (1990) presented a lesser limit of 0 – 5meq/kg. The result of this study is far from other authors findings on peroxide value of CPO produced and used in Nigeria (Akubor and Ogu, 2012; Akinola et al., 2010; Okechalu et al., 2011; Onwuka and Akaerue, 2006; Ohimain et al., 2012a; Aletor et al., 1990). Amata and Ozuor (2013) reported peroxide value of CPO produced from Delta North agricultural zone of Delta state via different processing methods as 11.3 –

15.00meqO<sub>2</sub>/kg (traditional), 7.33 – 11.00 meqO<sub>2</sub>/kg (semi-mechanized), 6.67 – 8.33 meqO<sub>2</sub>/kg (mechanized). Ngando *et al.* (2012) reported peroxide values of 2.07, 1.48 5.71 and 2.67meq/kg for traditionally, semi-mechanically and mechanically processed CPO produced in Cameroun.

Peroxide value is a measure of oxidation during storage and the freshness of the lipid matrix. Thus, it is the reactive oxygen that combined with the double bonds of the fatty acids in the triglycerides. During oxidation, the bonds are broken, resulting to short chain volatile compounds and residues of oxidized glycerides. Furthermore, it is a useful indicator of the early stages of rancidity (Ijeh *et al.*, 2011).

Peroxide value is a critical factor for examining the quality and stability of fats and oils, stages of oxidation and spoilage extent (Ohimain *et al.*, 2012a; RMRDC, 2004). Because of this, the oil could become harmful to human health due to the free radical that is generated during processing (Tagoe *et al.*, 2012; Ohimain *et al.*, 2013). The saponification value (181, 89) were found to be lesser than previous studies (Akinola *et al.*, 2010; Onwuka and Akaerue, 2006; Akubor and Ogu, 2012). Similarly, the saponification value of CPO sold in major market of some states in Nigeria 192.64 – 198.03 mgKOH/g (Abia) (Udensi and Iroegbu, 2007), 195.76 – 207.22 mgKOH/g (Delta) (Agbaire, 2012). Saponification value is an indication of the molecular weights of triglycerides of oils. High saponification value indicates high proportion of low fatty acids since saponification value is inversely proportional to the average molecular weight or length of fatty acids (Muhammad *et al.*, 2011). The saponification value gives information with regard to the solubility in water and soap formation (Akinola *et al.*, 2010; Ohimain *et al.*, 2013). Generally, the quality of palm oil is mostly determined by the FFA and moisture contents (Tagoe *et al.*, 2012). Different international bodies, authorities, institutions and locals have over the years published standards for consumption against which key parameters of crude palm oil with lower moisture content, provides better quality than that with higher moisture content because the more the moisture content, the more rapid the oil deteriorates in quality.

#### D. Conclusion

The results showed that mean value of quality parameters of the CPO samples are 0.15% moisture content; 5.71% impurity level; 0.935 specific gravity; 8.43% FFA; 52.13 iodine value; 13.71meq/kg peroxide

value; and 181,89 mg KOH/g saponification value. The quality parameters are associated with the method of processing.

#### References

1. Ngando, E.G.F., Mpondo, M.E.A., Dikotto, E.E.L. and Koono, P. (2011) Assessment of the quality of crude palm oil from small holders in Cameroon. *J. Stored Prod Postharv Res.*, Vol 2(3), pp. 52-58.
2. Madubuike, P.C., Ezigbo, I.J., Ekpe, I.O. and Onukwube, S.I. (2015) Evaluation of the Quality and Level of Adulteration of Palm Oil Obtained from Different Locations in Enugu Metropolis, Nigeria. *International Journal of Multidisciplinary Sciences and Engineering*, Vol 6 (6), pp. 23-26.
3. Oil world Ista GmbH Mielke (2007) Oil world annual 2006. Hamburg (Germany). Tagoe, S.M.A., Dickinson, M.J. and Apetorgbor, M.M. (2012). Factors influencing quality of palm oil produced at the cottage industry level in Ghana. *Int. Food Res. J.* 19 (1): 271 – 278.
4. Vaughan, J.G. (1990) The structure and utilization of oil seeds. London: Chapman and Hall Ltd. Zu, K.S.A., Adjei-Nsiah, S. and Bani R.J. (2012). Effect of processing equipment and duration of storage of palm fruits on palm oil yield and quality in the Kwaebibr.
5. May, Y.C. (1994) Palm oil carotenoids. United Nations University Press. *Food. Nutr. Bull.* Pp 15.
6. Ugwu, F. M., Odo, M. and Osborne, O. (2002) "The quality of locally processed palm oil from Ebonyi and Enugu States", *Proceedings of the 26th annual NIFST conference 4th-8th, Owerri, eds*", (C.N. Ubanonu, S.O. Eke, and A. Uzoma), pp. 47-48.
7. Lewkowitsch (1992) *Chemical Technology and analysis of oils, fats and waxes.* London: Chapman and Hall Ltd.
8. Ohimain, E.I., Izah, S.C. and Fawari, A.D. (2013) Quality Assessment of Crude Palm Oil Produced by Semi-Mechanized Processor in Bayelsa State, Nigeria.
9. Ohimain, E.I., Izah, S.C. (2013a). Gaseous emissions from a semi-mechanized oil palm processing mill in Bayelsa state, Nigeria. *Continental Journal of Water, Air and Soil Pollution*, 4 (1): 15 – 25.
10. Ohimain, E.I., Izah, S.C., Obieze, F.A.U. (2013b). Material-mass balance of smallholder oil palm processing in the Niger Delta, Nigeria. *Advance J. Food Sci. Technol*, 5(3): 289-294.

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11. Ohimain, E.I., Izah, S.C., (2013c). Water minimization and optimization by small-scale palm oil mill in Niger Delta, Nigeria.
12. Aletor, V.A., Ikhen, G. A. and Egharevba, V. (1990). The quality of some locally processed Nigerian palm oil: An estimation of some critical variables. *Food Chemistry*, 36: 311 – 317.
13. Akinola, F.F., Oguntibeju, O.O., Adisa, A.W., Owojuyigbe, O.S. (2010). Physico-chemical properties of palm oil from different palm local factories in Nigeria. *J. Food Agric. Environ.*, 8: 264-269.
14. Akubor, P. and Ogu, G.I. (2012). Quality attributes of fresh palm oil produced from selected communities around Anyigba, Kogi State, Nigeria. *Nigerian Journal of Nutritional Sciences*, 33(1): 12 – 17.
15. Ohimain, E.I., Daokoru-Olukole, C., Izah, S.C., Alaka, E.E. (2012a). Assessment of the quality of crude palm oil produced by smallholder processors in Rivers State, Nigeria.
16. Okechalu, B. and Gushop, T. (2011). Evaluation of the quality of palm oil produced by different methods of processing. *Research Journal of Biological Sciences*, 1 (1-4): 16-19.
17. Enemuor, S.C., Adegoke, S.A., Haruna, A.O. and Oguntibeju, O.O. (2012) African Foundation for Partnership Initiatives in the Niger Delta (PIND). A report on Palm Oil Value Chain Analysis in the Niger Delta, 2011.
18. Ngando, E.G.F., Mpondo, M.E.A., Dikotto, E.E.L. and Koona, P. (2011). Assessment of the quality of crude palm oil from smallholders in Cameroon. *Journal of Stored Products and Postharvest Research*, 2(3): 52-58.
19. Udensi, E.A., Iroegbu, F.C. (2007). Quality assessment of palm oil sold in Major markets in Abia State, Nigeria. *Agro- Science*, 6(2): 25 – 27.
20. Agbaire, P.O. (2012). Quality assessment of palm oil sold in some major markets in Delta State, southern Nigeria. *Afr. J. Food Sci. Technol.* 3(9):223-226.
21. Amata, I.A. and Ozuor, E. (2013) The effect of different processing methods on the quality of crude palm oil (CPO) in Delta North agricultural zone of Delta State Nigeria. *Inter J. Agri. Biosci*, 2(3): 116- 119.
22. Ijeh, I.I., Nwokohuru, O.W., Ejike, C.E. (2011) Oxidative stability of red palm oil from two oil palm varieties – *Elaeis guineensis* and *Elaeis oleifera*: comparative effects of storage temperature and duration. *Continental J. Food Science and Technology* 5 (2): 18 – 22.
23. Muhammad, N., Bamishaiye, E., Bamishaiye, O., Usman, L., Salawu, M. Nafiu, M., Oloyede, O. (2011). Physicochemical properties and fatty acid composition of *Cyperus esculentus* (Tiger Nut). *Tuber oil. Biores. Bull.* 5:51-54.