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Quality assessment of palm oil sold in some major markets in Delta State, southern Nigeria

Agbaire P. O.

Chemistry Department, Delta State University, Abraka, Nigeria
E-mail: patagbaire@gmail.com

Palm oil is one of the major fats and oils produced in Nigeria. It forms an important ingredient in the diet of many people in Delta State, Nigeria. The quality of palm oil is mostly determined by the following parameters: Free Fatty Acid (FFA) content, Iodine Value (IV), Peroxide Value (PV), Moisture Content, Saponification Value (SV) and Impurity Content. The objective of this study was to determine the quality of palm oil sold in major markets in Delta State, Nigeria. The results obtained showed that the Moisture content ranged from 0.14- 0.17%, Specific gravity from 0.859-0.889, Smoke value from 114.12-116.40^{o}C, Melting point from 34.5-35.6^{o}C, FFA from 2.73-2.83mg KOH/g, IV from 52.55-53.66Wij's, PV from 7.80-8.40meq/kg, SV from 195.76-198.75mg KOH/g, Impurity 0.11-0.14, Carotene from 1376.73-1568.59mg/kg. all the parameters investigated had values within the SON/NIS standards. The results obtained after analysis of variance (ANOVA) showed that there were no significant differences ($p > 0.05$) except for Carotene where there was significant difference ($p < 0.05$). In conclusion therefore, from the results obtained these palm oil samples were of good quality and there were no evidence of adulteration.

Keywords: Adulteration, palm oil, impurity, FFA, moisture content, Nigeria.

INTRODUCTION

The oil palm (*Elaeis*) comprise of two spieces. The African oil palm (*Elaesis guineensis*) is native to West Africa. The palm fruit takes five to six month to mature from pollination to maturity. The fruit is redish and each fruit is made up of an oily, fleshy outer layer (the pericarp), with a single seed (the palm kernel) also rich in oil. Oil is extracted from both the pulp of the fruit and the kernel.palm oil plant is the highest oil producing plant (Ngando et al., 2011) with an average 3.5tons of oil/ha/year. The oil is extracted from the mesocarp of the fruit. Crude palm oil represents 95% production of oil palm which also provide palm kernel oil. Since 2006, palm oil has become the world's most important edible oil (Ista 2007). Palm oil is used for edible purposes unlike palm kernel oil which is used in the oleochemical industry. In some tropical countries it contributes up to 80% of the total edible oil needs (Hirsch, 1999). This is one of African's most important oil producing plants (Vickery and Vickery, 1979). Palm oil is an important vegetable oil which is widely used in this part of the country. In fact, cultural it is more valued than other edible oils. It contains approximately 50% saturated fats

and 40% unsaturated fat. The light yellow to orange-red colour of palm oil is due to the presence of carotenoids in terms of retinol (provitamin A) equivalent (Vaughan, 1990; May, 1994; Ugwe et al., 2002). Palm oil can be refined industrially to give a light coloured product which can be used for other confectioneries (Ihekorunye and Ngoddy, 1985). The quality of palm oil could be affected by various factors ranging from improper post harvest handling, processing and storage. Recently, there has been wide spread speculation that palm oil is adulterated in order to increase profit margin. The quality of palm oil is generally determined by the percentage of free fatty acid (FFA), moisture, iodine value, saponification value, peroxide value and purity level. The objective of this work therefore was to assess the quality of palm oil sold in some major markets in Delta State, Southern Nigeria.

MATERIALS AND METHODS

The palm oil samples used for the experiment were purchased from major markets in Delta State, Southern

Table 1. Physiocochemical Properties of Palm Oil Samples (Mean±SD)

Parameter/Cities	Asaba	Agbor	Warri	Abraka	Obiaruku	SON/NIS standards
Moisture(%)	0.17±0.02	0.14±0.02	0.14±0.02	0.16±0.01	0.16±0.01	0.29%
Specific gravity	0.864±0.03	0.862±0.02	0.885±0.01	0.876±0.02	0.859±0.03	0.897-0.907
Smoke point(^{o}C)	115.5±1.11	116.4±1.11	115.33±1.76	114.12±1.76	115.33±0.90	
Melting points (^{o}C)	34.5±0.01	35.6±0.02	34.6±0.01	35.5±0.01	35.6±0.01	27-50^{0}C
Impurity level(%)	0.12±0.03	0.14±0.05	0.11±0.02	0.12±0.02	0.14±0.02	
Iodine value(Wij's)	53.05±0.44	52.55±0.40	53.64±0.58	52.55±0.44	53.11±0.49	45-53
Peroxide value (meq/kg)	8.37±0.55	7.80±0.45	8.27±1.64	8.40±1.60	8.38±0.46	10
Free fatty acid (FFA)(mgKOH/g)	2.83±0.09	2.73±0.07	2.79±0.14	2.76±0.15	2.82±0.07	3.5
Saponification value(mgKOH/g)	196.81±2.82	198.75±2.72	195.79±2.75	196.65±2.75	195.76±2.91	195-205
Unsaponifiable matter (g/kg)	7.80±0.04	7.70±0.02	7.40±0.05	7.60±0.05	7.65±0.04	10
Carotene value (mg/kg)	1546±30.66	1273±12.50	1376±19.55	1475.77±20.55	1568.57±29.90	500-2000

Triplicate samples were collected and analysed

Nigeria: Asaba, Agbor, Abraka, Warri and Obiaruku. All samples were collected in a 0.5L polyvinylchloride screw capped containers filled to the brim and firmly locked. The samples were kept at ambient temperature and then taken to the laboratory for immediate analysis (1-3 days after collection).

Moisture was assayed by the gravimetric method of air- oven drying to constant weight at 105°C.the free fatty acid (FFA) content was determined by titrating the alcoholic solution of the oil with a 0.1M NaOH using phenolphthalein as an indicator. The FFA content was then expressed as a percentage of palmitic acid being the major fatty acid in palm oil. The peroxide value was determined by titrating chloroform/glacial acitic acid/ saturated potassium iodide solution of sodium thiosulphate using 1% starch solution as an indicator. The smoke point and melting melts were determined according to the methods of Pearson (1976). Iodine value, saponification value, unsaponifiable matters were determined according to the methods of AOAC (2010). Carotene content was determined spectrophotometrically. The impurity level was determined as described by Ngando, et al., 2011. The oil samples were mixed with excess hexane, then filtered. The residue on the filter paper was the washed with hexane and oven dried to a constant weight at 105°C.

Statistical analysis

Analysis of variance (ANOVA) was used to test the data obtained. Each analysis was carried out in triplicate and the mean and mean deviation assessed.

RESULTS

DISCUSSION

The physicochemical properties of the palm oil samples are presented in Table 1 above. The moisture content of oils is an important parameter in assessing the quality of an oil sample. The moisture content of any food is an index of its water activity (a_w) (Fraziar and Westoff, 1978). High moisture content is an indication of ease of spoilage and rancidity as well as short shelf-life. The moisture content of samples ranged from 0.14-0.17%, which is lower than recommended standard of 0.29% (SON, 2000 and NIS, 1992). The low moisture content obtained will encourage the storage stability of the palm oil samples. It has been stated that the moisture content of palm oil depended directly on the efficiency of the final extraction and clarification processes (Wolves, 1969; Johansson and Pehlergard, 1977; Poku, 2002; Orji, 2006; Mbata and Orji 2008). Hartley (1988) ascertained that moisture could be removed from oil by boiling at elevated temperature. The results were similar to those obtained by Udensi and Iroegbu (retrieved 12/10/11). There was no significant difference ($\rho > 0.05$) in the moisture content of sample investigated .The value obtained for specific gravity ranged from 0.859-0.885. it is within the SON (2000) and NIS (1992) value of 0.897-0.907.

The smoke value ranged between 114.12-116.4^{o}C. There was no significant difference ($\rho > 0.05$). This high value is an indication of suitability of this palm oil for frying purposes.

The melting points ranged from 34.5-35.6^{o}C. the melting points are within the 27-50°C as recommended by SON, 2000. Thus these palm oil samples will remain as liquid at room temperature. There was no significant

significant difference (ρ>0.05)

The acid value is a measure of the free fatty acids in oil. Fatty acids are usually in the triglyceride form but during processing, the fatty acid may get hydrolysed into free fatty acids. The higher the acid value the higher the free fatty acid which also means decreased oil quality. Acceptable levels for all oil samples should be less than 0.6mg KOH/g (AOCS, 2003). It has been reported that ripe palm oil fruits contain autolipolytic enzymes which start to split the fruit oil to fatty acid and glycerol once the fruit is bruised (Bek-Nielsen, 1977; Esechie, 1978; Hartley, 1988). Free fatty acids could also be generated to some extent by contaminating lipases from microorganisms (Hiol et al., 1999; Houria et al., 2002). The presence of free fatty acid moieties in palm oil is an indication of the impairment of oil quality. The fatty acid obtained in this work ranged from 2.73- 2.83mg KOH/g. These values are higher than the recommended by AOCS, 2003 but lower than SON's recommendation of maximum 3.5mg KOH/g (SON, 2000). The results were also comparable with those of Egan et al., 1981; Ekpa and Ekpe, 1996; Ekwenye and Ijeoma, 2005; Ngando et al., 2006; Orji and Mbata, 2008; Okechalu et al., 2011). The high free fatty acid values obtained may be due to the fact that the palm oil samples were exposed to normal room temperatures at the market stores (Ekwenye, 2005). It may also be due to decomposition of glycerides by fungi and microorganism and may be accelerated by the exposure of palm oil to heat and sunlight (Hiol et al., 1999; Houria et al., 2002; Okechalu et al., 2011).

The iodine value is a measure of the level of unsaturation in oils. The value is a useful index of detecting adulteration of oils. It is a measure of the level of unsaturation in oils. The values obtained ranged from 52.55-53.66Wij's with no significant difference (ρ>0.05). The results were comparable with those obtained by Ekwenye and Ijeoma 2005, Udensi and Iroegbu, (2007), Okechanalu et al., 2011 but higher than those obtained by Orji and Mbata 2008. This high values shows some level of rancidity and deterioration. The results also suggest high level of unsaturation and susceptible to oxidative rancidity. The addition of antioxidants may be necessary to prolong the storage stability of the oil.

The peroxide value (PV) determines the degree of oil oxidation; it is a measure of oxidation during storage and the freshness of the lipid matrix. Furthermore, it is a useful indicator of the early stages of rancidity occurring under mild conditions. It is also a measure of primary lipid oxidation products (Onyeka et al., 2005). The PV is used as an indication of quality and stability of fats and oils (Ekwu and Nwagu, 2004; Nwanekeze and Oyeagba, 2007). The values obtained ranged from 7.80-8.40meq/Kg. These values are closely related to the standard value of 10meq/Kg specified by SON 2000and NIS 1992. They in fact all below the SON and NIS standard but the high values could indicate the onset of

primary oxidation due to lipid degrading enzymes like peroxidase and lipoxygenase (Onyeka et al., 2005).

Saponification value (SV) 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). Therefore the shorter the average chain length (C_4-C_{12}), the higher the saponification value (Tamzid et al., 2007). The values obtained are between 195.76-198.75mg KOH/g. These values are within the recommended range of 195-205mg KOH/g for palm oil (SON, 2000; NIS, 1992). These values are indication that the oils are well suited for soap making.

The carotene level of palm oil decreases with the time of storage. The results obtained for carotene level for these samples were quite reasonable and were within the recommended SON/NIS value indicative of the freshness of the palm oil samples. Palm oil is rich in vitamin A with carotene as the precursor (Ihekoronye and Ngoddy, 1985).

It has been reported that the impurity level depend directly on the efficiency of the final extraction and clarification procedures (Wolves-Perges, 1969; Johanssan and Pehlergard, 1977; Poku, 2002, Orji 2006). Hartley (1988, reported that impurities/ dirts are removed by filtration. The impurity levels of these samples ranged from 0.11-0.14, which is quite low. This goes to show the quality of the good production procedures.

CONCLUSION

The results obtained from the research showed that the quality of palm oil samples studied were within the recommended SON and NIS values. Therefore, it is reasonable to conclude that the palm oil samples studied were not adulterated and that the processing and storage methods employed were adequate. The results also indicate the suitability of the palm oil samples for both domestic and industrial uses.

REFERENCE

AOAC (1990). Official Methods of Analysis (15th edition). Association of Official Analytical Chemist, Washington, DC, USA 95-224.

AOCS (2003). Official Methods and Recommended Practice of American Oil Chemist Society. 5th ed. Champaign. Accessed on www.bioiginal.com

Bek-Nielsen B (1977). Quality Preservation and Testing of Malaysian Palm Oil from fresh fruit bunches to the oil refinery. In: International Society of Planters, Kuala, Lampur, Malaysia. 159-168

Egan H, Kirk RS, Sawyer R (1981). Pearson's Chemical Analysis of Food. 8th ed. New York, Churchill, Livingstone. 507-546

Ekpa OD, Ekpe UJ (1996). Effect of coconut oil concentration on the melting point profile and free fatty acid formation of palm oil. Nig. J. Chem. Res. 8:12

Ekwenye UN (2005). Chemical Characteristics of Palm Oil biodeterioration. Chem. Soc. Exper. Bio. 18:141-149

Ekweye UN, Ijeomah CA (2005). Antimicrobial effect of palm kernel oil and palm oil. KMITL Sci. J. 5(2):502-505

Ekwu FC, Nwagu A (2004). Effect of processing on the quality of Cashew nut oil. J. Sci. Agri., Food Tech. Envirion.4: 105-110

Esechie HA (1978). Mesocarp Oil and free fatty acid accumulation in oil palm fruits during ripening. Nig. Agri. J. 15:114-129

Fraziar WC, Westoff DC (1979). Food Microbiology. 3rd Ed. Tata Mcgraw-Hill Publishing Company Ltd, New York. 170

Hartley, CWS (1988). The Oil Palm. 3rd ed. Longman Publishers Ltd. Singapore, 1-256, 340-780

Hiol A, Comeau LC, Druet D Jonzo MD, Rugani N, Sarda L (1999). Purification and Characterisation of an extracellular lipase from a thermophilic *Rhizopus oryzae* strain isolated from palm fruit. Enzyme Microb. Tech. 26:421-430

Hirsch RD (1999). La Filière Huile de Palme au Cameroon dans un Perspective de Relance. Agence Française de Developpment. Paris (France) 79

Houria A, Comeau L, Deyris V, Hiol A (2002). Isolation and Characterisation of an extracellular lipase from *Mucor sp* strain isolated from palm fruit. Enzyme Microb. Tech. 31:968-975

Ihekornye AI, Noddy PO (1985). Integrated Food Science and Technology for the Tropics. Macmillian Publishers 75-77

Johannson G, Pehlergard PO (1977). Aspect on quality of Palm Oil. In: International Developments in Palm Oil. Earp, D. A. and Newall, W. (Ed). Society of Planters. Malaysia. 203-220

May YC (1994). Palm Oil Carotenoids. United Nation University Press. Food Nutr. Bull. 15

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

Ngando EGF, Mpaondo MEA , Dikotto EEL, Koona P (2011). Assessment of the quality of crude palm oil from smallholders in Cameroon. J. Stored Prod. Postharv. Res. 2 (3):52-58

NIS (1992). Nigerian Industrial Standards. Standard for Edible Vegetable Oil. 5-12

Nwanekezi EC, Oyeagba RA (2007). Effect of Spoilage Microorganisms on the physicochemical properties of African Pear Fruit Oil. J. Food Agri. Environ.5:90-93

Oil World Ista Mielke Gmbt (2007). Oil World Annual 2006. Hamburg. Germany.

Okechalu JN, Dashen MM, Lar PM, Okechalu B, Gushop T (2011). Microbiological quality and Chemical Characteristics of Palm Oil sold in Jos Metropolis, Plateau State, Niger. J. Microb. Tech. Res. 1 (2):107-112

Onyeka EU, Onugbu NI, Onuoha NU, Ochonogor F (2005). Effect of extracting pre-treatment on the Composition and Characteristics of seed and pulp oil of African Black pear *(Dacryodes edules*). Nig. Food J. 23:13-20

Orji MU (2006). In: Orji, M. U. and Mbata, T. I. (2008). Effect of Extraction Methods on the quality and Spoilage of Nigerian Palm Oil. Afr. J. Biochem. Res. 2 (9):192-196

Orji MU, Mbata TI (2008). Effect of Extraction Methods on the quality and spoilage of Nigerian Palm Oil. Afr. J. Biochem. Res. 2(9): 192-196

Pearson D (1976). The Chemical Analysis of Food. Churchill Livingstone, Edinburgh, London 121-150

Poku K (2002). Small Scale Palm Oil processing in Africa. Agriculture and Consumer Protection. FAO. Agricultural Services Bull. 148:62

SON (2000). Standard Organisation of Nigeria. Standards for edible refined palm oil and its processed form. 2-5

Tamzid HM, Alam MT, Islam MAU (2007). Physicochemical and Nutritional studies of *Terminalia belerica roxb*. Seed oil and seed kernel. J. Bio-sci., 15:117-126

Udensi, E. A. and Iroegbu, F. C.(2007) Quality Assessment of Palm Oil sold in major markets in Abia State, Nigeria. Agro-Sci 6 (2) 25-27

Ugwu FM, Odo M, Osborne O (2002). The quality of locally processed palm oil from Ebonyi and Enugu States. Proceedings of the 26th annual NIFST Conference 4th- 8th Nov. 2002, Owerri. Eds Ubbaonu CN, Eke SO, Uzoma A) 47-48

Vaughan JG (1990). The Structure and Utilization of Oil Seeds. Chapman and Hall Ltd. London:187

Vickery ML, Vickery B (1979). Plant Product of Tropical and Applied Ecology Series. 27-28

Wolves-Perges A (1969). Factors affecting the quality of Palm Oil. In: The quality and marketing og palm products. Turner, P. (Ed). The Society of Planters, Malasia. 42-52