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RESEARCH ARTICLE

EXTRACTION AND CHARACTERIZATION OF PALM KERNEL OIL FROM THE KERNEL OF PALM TREE (*ELAEIS GUINEENSIS*)

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ABSTRACT

Palm kernel oil (pko) was extracted from its kernel using Soxhlet extraction techniques with normal hexane as the solvent. The oil extracted was light brown in colour with no offensive odour. Proximate compositions of the palm kernel oil were determined and physicochemical analyses were also carried out on the oil extracted. The physicochemical analyses revealed moisture content of 0.89%; oil yield of 47.5%; specific gravity of 0.91; refractive index of 1.46; ash content of 5.30%; pH of 6.84; peroxide value of 10Meq/Kg; iodine value of 45.6mg/g; acid value of 3.53mg/g; free fatty acid of 1.775; saponification value of 187.93mgKOH/g; ester value of 184.4 mgKOH/g. The results of the investigation also showed that the oil was soluble in chloroform and ethanol, partially insoluble in both petroleum ether and carbon tetrachloride; and was insoluble in water.

INTRODUCTION

Palm kernel oil is a yellowish oil extracted from the kernel of palm nuts of palm tree (*Elaeis guineensis*), an indigenous wild tree of tropical Africa and part of Asia (FAO, 2000). It is dark-brown in colour when processed or extracted locally. The oil has distinct odour, but it can decolourized to colourless in the refining process or when exposed to excessive/high temperature. At the temperatures of 40°C, it can be stored for 6 months. Like any other vegetable oils and animal fat; it is a triglyceride which is chemically known as glycerol molecule with each of its three hydroxyl group esterifies with a long chain fatty acid. Its major fatty acid (lauric acid) is saturated; it is sometimes called lauric oil because it contains high percentage (C_{12}, 48.20%) of lauric fatty acid (Tooley, 1971). Other major fatty acids in palm kernel oil are myristic acid (C_{14}, 16%) and oleic acid (C_{18}, 15%) (Ugbogu *et al.,*., 2006; Pantazaris and Ahmed, 2004). Palm kernel seeds contain about 75-80% oil which can be extracted by varieties of methods or combination of methods such as: mechanical screw-press, solvent extraction and traditional methods. However, the most satisfactory approach/method is mechanical screw-press which can extract every possible drops of the oil; the next is the solvent extraction (Jin, 2008). The composition of the product depend on several criteria particularly the geographical occurrence, its botanical origin, handling of the seeds (processing). It is reported by Sonau and others in 2006 that variation in the physicochemical composition of the oil has been attributed to environmental factors such as rainfall, soil fertility, maturation period, agronomic practices and genetic substitution.

Obviously, palm kernel oil is an important source of fat. Palm kernel oil is used in food processing industries, soap making, cosmetics, pharmaceutical industries, and traditional medicine in many rural areas and as lubricant or biodiesel (Alander, 2004). This work is aimed at extraction and characterization of palm kernel oil (PKO). These will be achieved through the realization of the following objectives: extraction of palm kernel oil from it seeds using soxhlet extraction method and investigation and determination of the physicochemical properties (characterization) of palm kernel oil using standard methods.

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MATERIALS AND METHODS

Collection of samples

The palm kernel nuts were sourced from Ibuo Palm Plantation, Ekoli Edda, Ebonyi State, Nigeria. The palm kernels used were of Dura variety with thin mesocarp. The shells of the palm kernels were removed using palm nut cracker developed by NOVA Technologies, Nigeria. The palm nuts were screened to remove the foreign matters and the defective ones. The kernel was dried in the oven (EYELA, VOC-300 CD, Tokyo, Japan)

at the temperature of 50℃ for 8 hours. The normal-hexane used for extraction was of Analytical grade (BDH, London).

Extraction of Oil

The extraction of palm kernel oil was done with a soxhlet extractor according to the method described by Ogburubi *et al.,* (2009) using n-hexane (boiling point of 40-60℃) for about six hours. The oil was obtained after the solvent was removed under reduced temperature and pressure and refluxing at 70℃ so as to eliminate the solvent remaining in the oil after extraction. The extracted palm kernel oil was stored in a freezer at 4℃ for subsequent characterization.

Characterization of Palm Kernel Oil

Some of the physical and chemical characteristics of palm kernel oil were determined. These include oil content, moisture content, specific gravity, refractive index, iodine value, saponification value, acid value, peroxide value and ester value. Also determined was the degree of solubility of the oil to different solvents. The characterizations were determined by using the standard Association of Official Analytical Chemists (AOAC, 1990) methods.

RESULTS

Palm Kernel Oil (PKO) was characterized along the following physicochemical parameters and the results are shown in Table 1.

Table 1. Results of the Physicochemical Parameters of Palm Kernel Oil

S/N	Parameters	Results
1	Moisture content (%)	0.5 ± 0.016
2	Specific gravity	0.91 ± 0.008
3	Refractive index	1.46 ± 0.025
4	Ash content (%)	5.30% ± 0.163
5	Oil content (%)	47.5% ± 0.245
6	pH value	6.84 ± 0.033
7	Odour	Not offensive
8	Moisture content of the oil (%)	0.89% ± 0.029
9	Colour	Light brown
10	Clarity (Opacity)	Slightly clear
11	Taste	Distinct
12	Peroxide value (Meq/kg)	10 ± 2.160
13	Iodine value (mg/g)	45.6 ± 0.082
14	Acid value (mg/g)	3.53 ± 0.025
15	Free Fatty Acid (FFA %)	1.775 ± 0.004
16	Saponification value (mgKOH/g)	187.93 ± 0.025
17	Ester value mgKOH/g	184.4 ± 0.163

Table 2. Solubility Status of Palm Kernel Oil in Solvents

S/N	Solubility	Palm Kernel Oil
i.	Chloroform	Soluble
ii.	Petroleum ether	Partially soluble
iii.	Carbon tetrachloride	Partially soluble
iv.	Ethanol	Soluble
v.	Water	Insoluble

DISCUSSION

Table 1 presents the results of the oil yield and the physicochemical parameters of palm kernel oil (PKO), while Table 2 presents the level of solubility of this oil in different solvents. The result obtained for the percentage of oil content of the palm kernel oil (PKO) was 47.5 % and this falls below the range 75-80% found in Asuquo (2008). The mode of extraction and the fruit specie are very important factors affecting the percentage yield of the oil. It is reported that, best available methods for extraction of pko at present is by the use of mechanical screw press (Jin *et al.,* 2008). The specific gravity (0.91) was the same with that of palm oil, moringa seed oil and groundnut reported in (Ebuchi *et al.,* 2006 and Abiodun *et al.,* 2012). Saponification value represents a relation of how much (weight) of alkalis needed to saponify a fixed mass of oil. The value differs from oil to oil because their free fatty acids are molecules of different sizes, which mean for a given mass of oil there is a different number of FFA. The saponification value obtained from the study was 187.93mg/g and this falls within the range (185-205mg/g) of saponification value of pko found in literature, and the range of other common oil such as soya bean (189-205 mg/g) and cotton seed oil (189-198 mg/g). The higher the saponification value of oil, the higher the lauric acid content of that oil. The lauric acid content and the saponification value of oil serve as important parameter in determining the suitability of oil in soap making (Asuquo *et al.,* 2010). The result of the analysis showed that the iodine value was 45.6 Wijs and it falls below the values reported by (Abiodun *et al.,* 2012 and Mabaleha *et al.,* 2007). This low value indicates the degree of unsaturation of the oil. Low iodine values bring about the stability of oil to oxidation. Knowledge of the iodine value enables the combustion temperature of the oil to be evaluated (Roger *et al.,* 2010). The peroxide value obtained was 10.00Meq/kg and was lower than those of Shea butter oil (14.20Meq/kg) found in literature, but equals the codex standard value (10Meq/kg) and lower than the maximum value (20Meq/kg) allowed for unrefined olive oil (FAO/WHO, 1993). The lower value indicates that pko has less susceptibility to rancidity. The pH value obtained for the palm kernel oil was 6.84 indicating that the oil was more acidic than other edible vegetable oil such as red palm oil with pH of 7 (Asuquo, 2008). The percentage of moisture content obtained for the palm kernel oil extracted was 0.89 and this was far lower than the value found in red palm oil (5%) and other vegetable oil such as, cashew nut oil (8%), shea butter oil (10%) and rubber seed oil (8.60%) (Asuquo, 2008).

This low moisture content was as a result of proper sample treatment and processing of oil. Acid value is the amount of free fatty acid present in fat as measured by the milligrams of potassium hydroxide needed to neutralize it. The lower the acid value of an oil, the fewer the free fatty acids it contains (Asuquo *et al.,* 2010). The acid value obtained for the palm kernel oil was 3.53 mg/g while the FFA was 1.775% and this varies with the range of other vegetable oils such as red palm oil (5.50mg/g and 2.765%), *Amaranthus hybridus* (2.82mg/g and 1.418%), castor seed oil (14.8mg/g and 7.441%), Shea butter oil (1.79mg/g and 0.900%) (Roger *et al.,* 2010; Asuquo *et al.,* 2010). This result indicated that pko is more acidic than red palm oil. The more acidic nature of the oil indicates its high free fatty acid content. Low acidic value implies rather stable oil at the extraction temperature (Codex, 1993). Ester value is number of mg of potassium hydroxide (KOH) required to saponify the esters in 1g of a sample. It is the difference between the saponification value and the acid value. The result

of the analysis showed that the ester value obtained was 184.4 mgKOH/g and this was higher than the value for castor seed oil (163.2 mgKOH/g) and Shea butter oil (183.4 mgKOH/g) (Abitogun *et al.,* 2009 and Asuquo, 2008). The solubility status of the oil as presented in Table 2 showed that the palm kernel oil was soluble in chloroform and ethanol. It was insoluble in water and partially soluble in petroleum ether and carbon tetrachloride.

Conclusion

The physicochemical analysis, as shown from the results presented showed that the oil has good yield and can be very good for commercial soap production, food and pharmaceutical industries**.**

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