Solvent Extraction and Characterization of Dika Nut (*irvingia gabonensis*) Oil

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Abstract: Oil was extracted from African bush mango (Irvingia gabonensis) seeds employing soxhlet extraction method. Soxhlet apparatus was used in extracting the oil with normal hexane as the extracting solvent and at a temperature of 60°C. The average oil yield obtained was 64.28%. Characterization was conducted to determine the physical and chemical properties of the extracted oil. The results obtained from the analyses carried out are as follows: It is pale yellow in colour, solid at 28°C, with melting point of 40°C, refractive index of 1.38, viscosity of 54.6m/s, and a specific gravity of 0.92g/cm^3; The results for the chemical properties are: 6.732mg/KOH/g (free fatty acid), 76.55g/100g (iodine value), 3.37mgKOH/g (acid value), 2.5mmolperoxide/kg (peroxide value), and 215.99mg/g (saponification value). From the result obtained for saponification value, it indicates high proportion of fatty acids which shows that the oil may have a potential for use in soap making and cosmetics industry. Also, the free fatty acid and acid value reflects the freshness and edibility of the oil, while the peroxide value further confirms its stability. These results obtained, suggest that this oil has potentials for wide industrial applications in Nigeria, such as in soap making, pharmaceutics, cosmetics, as well as in food industries.

Keywords: *Characterization, African bush mango, physical properties, chemical properties, oil yield*

1. Introduction

Irvingia gabonensis commonly known as "Dika nut", "African mango" or "bush mango" grows naturally in the humid, lowland forest of tropical Africa but is widely planted in Central and Western Africa and is well known for its edibility and termite-resistant wood (Harris, 1996 and Ladipo, 1995). Burkill (1994) reported that the tree grows in season as high as 40m and becomes laden with green and yellowish fruit that looks like small mango.

The fruit is a drupe with a thin outer skin, soft fleshy pulp when ripe, and a hard stony nut encasing an extremely soft kernel (Okafor, 1978). Lowe (2000) and Anegbeh (2003) reported that this plant is largely used in traditional and modern medicine for the treatment of several illnesses, as well as in industries. Two species of the tree: *Irvingia gabonensis*, which has a sweet edible pulp and *Irvingia wombolu,* which has a bitter inedible pulp, are common; however, kernels from both species exhibit similar valuable food properties (Omogbai, 1987 and Ejiofor, 1994). Some are pounded into Dika butter, some are compacted into blocks resembling chocolate (once called Gabbon chocolate) and some are pressed to squeeze out the oil that makes up more than half the kernel weight. In the main, the kernel are grounded and combined with spices to form the key ingredient in "Ogbono soup", a valuable local delicacy in Nigeria, Ghana and Gabon (Eka, 1980).

Kernel meal is high in oil and protein (including six of eight essential amino acids), and would make an exceptional tool for nutritional intervention in West and Central Africa where marasmus and kwashiorkor are the main baby killers. Osagie and Odutuga, (1986) reported that the kernel contains about 8.9% protein, 19.7% carbohydrate, 62.8%

lipids, 5.3% dietary fibre and 3.2% ash by weight. It constitutes an important part of the rural diet in West Africa for controlling dietary lipids and weight gain (Leakey, 2005 and Ogunsina, 2008).

Although various oil-rich tropical seeds are being advanced to meet nation's needs for food, energy, and protein, few are employing dika for the purpose. While the kernel meal is high in oil and protein, and would make an exceptional tool for nutritional intervention in West and Central Africa, it has remained largely underexploited most especially in Nigeria. Dika seed is very useful because of its numerous and available nutritional properties. Many studies undertaken on the nutritional or medicinal value of *Irvingia gabonensis* seed have been reported, but little has been done on the extraction of the oil, thus necessitating this research work.

2.0 Methodology

The seeds of Dika nut (*Irvingia gabonensis*) were obtained from Uzebba village in Edo State and were sun dried to moisture content of 6.47%.

2.1 Procedure for extraction

The dried kernels were milled into fine granules using a hand milling machine (5C Landersy CIA). This was done in order to create a large surface area for improved extraction of oil (Mohammed and Hamza, 2008).

Oil was extracted with a soxhlet apparatus using the solvent extraction method as described by A.O.A.C (2000).

2.2 Characterization of extracted oil

The extracted oil was subjected to analysis as described by A.O.A.C (2000) to determine the following parameters: Refractive index, viscosity, colour, odour, specific gravity, saponification value, acid value, iodine value, free fatty acid value, peroxide value, melting point, and solidification temperature of the oil.

3.0 Results and Discussion

3.1 Results

The results obtained from this study are presented in Tables 1.0 and 2.0. The tables include the physical and chemical properties of the extracted oil.

Table 1.0 Physical Properties of the Extracted Oil

S/n	Parameters	Values	
1	Refractive index	1.38	
2	Specific gravity	0.92g/cm^3	
3	Colour	Pale yellow	
4	Solidification point	28°C	
5	Melting point	40°C	
6	State at	28°C	Solid
7	Viscosity	54.6mm^2/s	
Average Oil Yield		64.28%	

Table 2.0 Chemical Properties of the extracted Oil

Parameters	Values
Saponification Value	215.985mgKOH/g
FreeFattyAcidvalue	6.732mg/KOH/g
Acidvalue	3.366mg/KOH/g
Iodine value	76.55mg/100g
Peroxidevalue	2.5mmolperoxide/kg

3.2 Discussion of Results

The Moisture content of the seed prior to extraction was 6.47%. The experiment was carried out seventeen times and the percentage yield varied between 57.32 68.95%, giving an average oil yield of 64.28%. The average oil yield extracted by solvent (64.28%) is higher than that obtained by press (34.55%) reported by Womeni *et al.*, (2006). The oil yield is high and is in close agreement with the value 53.54 72.63% reported by Knothe *et al.*, (1997). This indicates that the seed is a very good source of abundant oil. The oil content is higher than that of some conventional oil seeds: cotton seed; 18- 26%, linseed; 30- 47.8%, poppy seed; 45-50%, kapok seed; 22.6- 25%, mowrah seed; 50-52% (Cantor, 1992).

Tables 1.0 and 2.0 present the Physical and Chemical properties of Oil extracted from *Irvingia gabonenesis* seeds. At ambient temperature, the oil extracted is whitish and solid, while when melted at 40°C, it is pale yellow liquid. It has a specific gravity of 0.92g/cm^3 which shows that it is less dense than water. This value is consistent with the value 0.901g/cm^3 obtained by Tint and Mya (2009), as well as the value 0.902g/cm^3 obtained by Belewu *et al.*, (2010) for jatropha curcas seed oil. The refractive index indicates the level of optical clarity of the crude oil sample relative to water. A refractive index of 1.38 which is slightly in agreement with the value 1.46 obtained for the African star apple seed oil as reported by Ochigbo and Paiko (2011) shows that the oil is not as thick as most drying oils whose refractive index fall between 1.475 and 1.485 (Akinhanmi and Akintokun, 2008).

The obtained iodine value 76.55mg/g of African mango seed oil is higher than that obtained for African star apple seed oil 31.06 ± 0.80mg/100g by Akubugwo and Ugbogwu (2007). The iodine value is also higher than 63.0mg/g obtained for shea nut oil. The higher the iodine value, the greater the unsaturation of the fat and the higher the unsaturation of the fat, the lower the solidification point. Therefore, the oil not being in liquid form at ambient or room temperature is as a result of the unsaturated fatty acids present which is seen from the high iodine value gotten. Oils are classified as drying, semi-drying and non-drying according to their iodine values. As the iodine value of *Irvingia gabonenesis* is less than 100, it could be classified as non-drying oil. The iodine value indicates that the oil could be employed for soap making and in the manufacture of leather shaving cream (Eka, 1980 and Nzikou *et al.*, 2007). Its suitability for the manufacture of soaps, lubricating oil, lighting candles and manufacture for lather shaving cream is an attractive option because this oil is not in much use for commercial consumption and will help to minimize dependency on use of known edible oils for making such products (Ochigbo and Paiko, 2011).

Acid value is a direct measure of the percentage content of free fatty acids in a given amount of oil. It is a measure of the extent to which the tryglycerides in the oil have been decomposed by lipase action into free fatty acids. Acid value depends on the degree of rancidity which is used as an index of freshness (Ochigbo and Paiko, 2011). The Free Fatty acid and acid value obtained are

6.732mg/KOH/g and 3.366mg/KOH/g. The bottom grade of the % FFA indicate that this oil will be good salad oil and can be stored for a long time without fearing deterioration due to oxidizing rancidity. The acid value obtained is low compare to 4.0mg/KOH/g as reported for sesame, soya bean, sunflower and rape seed. It is common knowledge that these parameters are a measure of the level of spoilage of oil, hence, it could be concluded that the fact that they are of low magnitude is a reflection of the freshness and edibility of the oil.

The peroxide value content is 2.5mmolperoxide/kg sample which indicates that the oil is fresh because the content peroxide is lower than 10mmolperoxide/kg which is the maximum acceptable value set by the Codex Alimentarius Commision for such oils as groundnut seed oils (Abayeh *et al.*, 1998). The higher the peroxide value of the oil, the greater the development of rancidity and this limits its value in the food industry. Oils having higher peroxide values like 20 to 40 results to rancid taste and unstability. Oils that the peroxide values lay between 1□10 are saturated; therefore, there is no risk of peroxide formation and can be of great value in food industry.

The saponification value obtained in this study (215.985mgKOH/g) is higher than (179.52mgKOH/g) obtained for *Dacrodes edulis* pulp oil reported by Nzikou *et al.*, (2007) and those of oils extracted from conventional oil seeds such as: Soybean oil (190mgKOH/g), Moringa seed oil (190□ 205mgKOH/g), Groundnut seed oil (186□ 195mgKOH/g) and cotton seed oil (192mgKOH/g) (Knothe *et al.*, 1997). The high value obtained suggests that the oil could be good for soap making and in the manufacture of lather shaving cream (Eka, 1980 and Nzikou *et al.*, 2007). As reported by Ezeagu *et al.*, (1998), a saponification value of 200mgKOH/g indicates high proportion of fatty acids of low molecular weight. This shows that the oil may have a potential for use in soap making and cosmetics industry and for the thermal stabilization of poly vinyl chloride (PVC). These properties make them useful as sources of essential fatty acids required in the body (Akanni *et al.*, 2005). Also, this saponification value obtained is within the range of edible oils as reported by Eromosele *et al.*, (1994).

4.0 Conclusion

Proximate analysis of African Bush Mango (*Irvingia gabonensis*) seed oil showed that they are high lipid sources. In view of this, it could be concluded from the results of this research work that *Irvingia gabonenesis* seeds may be developed for oil production, and its high percentage of oil content would contribute to meet the world's ever growing demand for vegetable oil. The oilseeds of these tropical plants are predisposed to human consumption due to their low content in FFA and peroxide. Saponification values and physical properties of these oils indicate that it is non□drying oil and may be used in cosmetic industries for skin care products as soaps, lather shaving, protector creams and as lubricating oil and lighting candles. It may not be suitable for oil paint, varnishes and surface coating due to its non□drying attribute. The acid content make them more nutritionally balanced than most of the conventional advisable oils such as sesame, rape,

and sunflower. The oil extracted from *Irvingia gabonensis* seed kernels is saturated, which is a source of lauric and myristic acids.

In view of all these potentialities and qualities, *Irvingia gabonensis* seeds may be considered as source of non-conventional oils which could be used in pharmaceutical, cosmetic and food industries.

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