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Physicochemical Properties and Fatty acid composition of Dikanut *(Irvingia Gabonensis)* seed oil

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Abstract

Nigeria is one of the countries of the world with a variety of oil seeds, therefore the potential of Nigeria leading Africa, and the world at large, in the area of seeds oil production was examined by evaluating the fat content, physicochemical qualities, and fatty acid content of oil extracted from dikanut (Irvingia gabonensis) seed, bought from Owode market in Offa local Government area of Kwara State, Nigerian. The fat content of Irvingia gabonensis was 22.50 ± 0.2 %. The chemical qualities iodine, peroxide, saponification, and acid values, free fatty acid, and unsaponifiable matter were analyzed using standard methods, and the values, were found to be 4.50±0.1gI_2/100g, 1.80±0.1 meq/kg, 187.90±0.3 mgKOH/g oil, 9.40±0.2 mgKOH/g oil, 4.70±0.2% FFA as oleic acid and 1.50±0.5% respectively. The physical properties were solid at room temperature, grey yellow in colour, melting point (13+1^oC) and specific gravity 0.88+0.2kg/dm^3. The oil contained six major fatty acid in the following other lauric > myristic > stearic > palmitic > oleic > linolenic acid. The result reveals that the oil extracted can be useful both domestically and industrially.

Keywords: Physicochemical, extraction, *Irvingia gabonensis*, oil, fatty acid.

Introduction

Trees and shrubs with medicinal and nutritional potentials abound in Nigeria. Several of these plants have fruit which have been identified to be nutritionally important[1]. In recent times, the desire to conserve resources spent on importation of oil for domestic and industrial use gave renewed impetus in the search for novel sources to complement the traditional ones. Attention has therefore been focused on under-utilized local seeds for possible development and use. There are several of these under-exploited plant seeds in Nigerian[2].

Dikanut *(Irvingia gabonensis*) belongs to the simarubaceae family and is commonly known as African mango. The fruit is yellow when ripe and the pulp is edible but has a turpentine flavor. The seed ranks as an oil seed and is used as a popular soup thickener in Nigerian[3]. The Irvingiaceae Kernels are part of the non-timber forest products whose economics and food importance appear undeniable, but despite their importance the Irvingiaceae do not benefit from good valorization and exploitation on a large scale[4]. There are six species of Irvingia in the Congo Basin, namely: *Irvingia gabonensis*, *Irvingia grandifolia*, *Irvingia smithii, Irvingia wombulu, Irvingia excelsa and Irvingia robur*[5], where only *Irvingia gabonensis* and *Irvingia wombulu* species appear to be well known, and are the subject of several transaction and some physiochemical studies[6,7].

Many studies undertaken on the nutritional and medicinal value of *Irvingia gabonensis* have been reported[8-10] etc., work on other species include *Irvingia smithii*[4], *Irvingia wombulu*[11]. Methanolic extract of *Irvingia gabonensis* are used in the treatment of bacterial and fungal infections[12]. Seeds oils have extensive demands both for human consumption and for industrial applications[13] and also have been rated as the second most valuable commodity in the world trade today[14]. Numerous researchers[10,13,15-19], among others have carried out a lot of analytical works on seeds primarily because of extensive and increasing demands for both human consumption and numerous industrial applications. Consequently, there is an increasing need to perpetually search for oils from non-conventional sources to augment the available ones and also to meet specific applications. Attention has not been focused on under-utilized agricultural foods and industrial products. This study therefore, is designed to search for oil from non-conventional sources because of the increasing needs for oils both for human consumption and

industrial applications. The physicochemical properties and fatty acid content of oil extracted from *Irvingia gabonensis* was studied to a certain its suitability for both domestic and industrial applications.

Material and Methods

Sources and preparation of sample: The sample dikanut *(Irvingia gabonensis*) seed was bought from Owode market in Offa Local government area of Kwara State, Nigeria. The seed was screened to remove the bad ones and stones. They were dried to constant weight in an oven at 60-65^oC for 24hours to

reduce moisture content and then grounded using a mechanical grinder, put in an air tight container and stored in a desicator for further analysis.

Oil extraction and analysis: The seed oil was extracted using the continuous soxhlet extraction technique with petroleum ether (40-60^{o}C) for 5hrs. After removing solvent, using a Rotavapor apparatus, the seed oil obtained was drained under a stream of nitrogen and stored in freezer (-30^{o}C) for subsequent chemical analysis. Standard methods were used in all the analysis saponification value[20], unsaponifiable matters, and percentage free fatty acid as oleic acid, and acid valued, peroxide value, iodine value, fat content[21]. Specific gravity was determined using hydrometer[22]. Refractive index was determined using a refractometer and colour, colorimeter, smoke point, melting and setting points[21]. Fatty acid composition was determined as their methyl esters prepared by boron-trifluoride methanol complex method[21]

Results and Discussion

The studied chemical properties of dikanut *(Irvingia gabonensis*) seed oil are shown in table-1. The fat content was 22.50±0.2%, lower than that reported for castor seeds (57.33±1.63), coconut seeds (42.00±2.21), dikanut (62.80±2.4), groundnut seeds (40.80±0.50), melon seeds, (53.04±1.62), oil beans seeds (52.07±1.45) and palm kernel seeds (54.18±1.88)[10], different varieties of tobacco seeds cultivated in Bangladesh range 42.29±0.60-45.72±1.20[18], seed kernel of *Irvingia smithii* of Congo Basin (54.52±2.61)[4], *Canarium schwenfurthii* fruits (36.10%), *Balanites aegyptiaca* almonds (48.30%) [23], *Dacryodes edulis* pulp (29-67.50%) [24], and *Irvingia gabonensis* seed kernels from two Congo Brazzaville localities , sibiti (3.69^{o}S; 13.35^{o}E) IGS-(34.55-73.82%), and Ouesso (1.61^{o}N, 16.05^{o}E) IGO-(34.28-62.27%)[9].

Table-1
Chemical properties of oil extracted from Africa wild mango (*Irvingia gabonensis)* seed

Chemical parameter	Composition
Iodine value (IV) (gI_2/100g)	4.50±0.1
Peroxide value (PV) (meq/kg)	1.80±0.1
Saponification value (SV) (mgKOH/g.oil)	187.90±0.3
Acid value (AV) (mgKOH/g oil)	9.40±0.2
% free fatty acid (FFA) as oleic acid	4.70±0.2
Unsaponifiable matter (%)	1.50±0.5
Fat content (%)	22.50±0.2

[a] value are means ± standard deviation of triplicate determinations

The saponification value was 187.90±0.30 mgKOH/g oil which was below the range reported for *Irvingia gabonensis* from two localities in Congo Brazzaville (IGO) 189.92±4.6-237.69±72mgKOH/g oil, and (IGS) 196.32±6.2-277.69±2.5 mgKOH g oil[9]. The value was also lower than that reported for *Dacryodes edulis* pulp oil (201)[25], those of oil extracted from conventional oil seeds as soya (189-195), groundnut (187-196) and cotton (189-198)[26], it was also higher than that reported for *Chrysophyllum albidum* (126.30±3.50), *Landolphia owariensis* (42.40±3.00) and *Napoleana imperialis* (77.06±4.0) but lower than *Dacryodes edulis* (191.10±3.80)and *Elaeis guineensis* (246.60±4.2)[2] . However, saponification value is used to check adulteration[2]. The relatives high value recorded for this sample is an indication that it have potential for industrial used[16,25].

Table-2
Physical properties of oil extracted from African wild Mango *(Irvingia gabonensis)* seed (Means, n = 3)[a]

Properties	Value
State at room temperature (27 ± 1^{o}C)	Solid
Colour	Grey yellow
Smoke point (^{o}C)	78±2 ^{o}C
Melting point (^{o}C)	13 ± 1
Specific gravity Kg/dm^3	0.88 ± 0.2
Setting point (^{o}C)	25.30 ± 1.20

[a] values are means ± standard deviation of triplicate determination

Table-3
Fatty acid composition of dikanut *(Irvingia gabonensis*) seed(Mean n=3)[a]

Fatty acid	% composition
Oleic	6.90 ± 0.2
Myristic	20.50 ± 0.2
Stearic	11.40 ± 0.1
Linolenic	6.40 ± 0.2
Palmitic	10.30 ± 0.2
Lauric	39.40 ± 0.5

[a] value are means ± standard deviation of triplicate determination

Iodine value was 4.50±0.1 gI_2/100g, confirming the values 4.3±0.10-4.80±0.69 for IGO var and 4.10±0.01-4.90±0.05 for IGS var reported for *Irvingia gabonensis* from two localities in Congo Brazzaville[9]. This value was lower compared to that reported for *Cocos nucifera* range (9.93-10.99)[15,27], *Colocynthis citrullus* range (110.93-111.46)[27]. It was higher than 2.65-3.45 reported for *Colocynthis citrullus, Cucumeropsis edulis and Prumus amygdalus* [28] ,but lower than those reported for most non-conventional plant seeds in Nigeria and Congo Brazzaville[13,15,29,30], *Solanum nigrum L* (102.8-103.25), and *Amaranthus hybridus* var. 1 and 2 (109-112.92) from Congo Brazzavelle[29,30] and *Telferia occidentalis* (114.0) and *Citrullus vulgaris* (114.50) from Abeokuta[19]. A good drying oil should have iodine value of 180 and above[26]. Thus, the value obtained for these seed (*Irvingia gabonensis*) classify it as a non-drying oil, as such the seed oil will not be suitable as alky resins for point formulations or used as varnishes, it may however found use in conjunction with amino resins as finishes for certain appliances and in this case, the oil can act as a plasticizers. The

relative low iodine number of the seed oil may be an indicative of the presence of few unsaturated bonds and low susceptibility to oxidative rancidity.

Peroxide value was 1.80±0.1 meq/kg comparable to *C. albidum* (1.8±0.28), *N. Imperialis* (1.55±0.35) but lower than *E.guinensis* (2.12±0.41*), L. owariensis* (2.80±0.50) and *D. edulis* (21.23±1.50)[2]. The value was higher than for *Cocos nucifera* (0.21) but within the range for *Colocynthis citrullus* (1.53-2.72)[27]. The value compares favourably with the range (0.39-7.40) reported for non-conventional seed oils in Nigerian and Congo Brazzaville[15,19,28,29,30] and the range (0.23-1.80) obtained for the studied conventional oils in the Nigerian markets [27]. However, it was lower than *B. parii* (97.50), *L. lanceolata* (95.0), *S. setegera* (35.0), *D. Microcarpum* (150.0), *B. Sapida* (135.0) and *S.birrea* (25.0)[13]. Peroxide values are used as indicator for deterioration of oils. Fresh oils have peroxide values less than 10 meq O_2kg^{-1}, [26] ,while values above 20 indicates rancid taste and disagreeable odour. The low peroxide value of this seed oil indicates low level of oxidative rancidity of the oil and also suggests the presence for high level of antioxidant.

Acid value is used as an indicator for edibility of oil and suitability for use in the paint industry. The value for these study was 9.40±0.2 mgKOH/g oil, little above the range 1.20-8.4, mg NaOH g^{-1} reported for *Telferia occidentalis*, *Citrullus vulgaris, Colocythis citrullus*, (from Akure and Kano), *Pentaclethra macrophylla*, *Treculia africana* and *Cocos nucifera* [15,19,27,28], but compared favorably with the range (3.74±0.23-25.62±0.29) for most conventional oils (Rape seed, soya bean, Wangasa, Kings, Turkey, Filma, Gino and Controller oils) sold in Nigerian markets[27]. The acid value of the sample studied, fell within the allowable limits for edible oils[26], therefore the oil is edible. The free fatty value was 4.70±0.2% (as oleic acid) was higher than *C. albidum* (1.76±0.10), *D. edulis* (2.78±0.02), *N. impreialis* (2.60±0.07) but lower than *E. guinesis* (7.06±0.01) and *L. owariensis* (7.70±0.11)[2], also higher than that reported for three varieties of tobacco seed oil (1.51-2.30)[18]. The oil has low acid value and a corresponding low level of free fatty acid, which suggests low level of hydrolytic and lipolytic activities in the oil, thus the seed oil studied could be a good source of raw materials for industries.

The unsaponifiable matter was 1.50±0.50%, which was comparable to that reported for three tobacco varieties 1.39-1.45%[18], but lower than that obtained for *Psophocarpus tetragonolobus* (1.63%) and orchid fruits *Myristica* (1.79%) oil seeds[31]. Unsaponifiable matter includes hydrocarbons, higher alcohols and sterols (e.g. Cholesterol, phytosterol)[18]. Most oils and fats of normal purity contain less than 2% of unsaponifiable matter.

Table II showed the physical properties of oil extracted from dikanut (*Irvingia gabonensis*) seeds. The oil was solid at room temperature (27±1°C) and grey yellow in colour. The specific gravity was 0.88+0.2, comparable to the range 0.88-0.93 for *Cocos nucifera* seeds but little below the range for *Cocoynthis citrullus* (0.90-0.92) [27]. The specific gravity value 0.88±0.2, ranked favorably with the range of specific gravities 0.81-0.928 reported for other oils, fats and waxes from common plant seeds in Nigerian[2, 15, 19]. However, the value was low compared to those reported for seeds from Akure, *Colocynthis citrullus* (1.51), *Cucumeropsis, edulis* (1.67) and *Prunus amygdalus* (1.71)[28]. The smoke point was (78.0±0.2°C), lower than that reported for three varieties of tobacco seeds oil (214±1.41-230±0.81)[18], soyabean oil (250.00±5.77°C), *Blighia sapida* (220±2.88°C)[32]. Smoke point of a fatty material is measure of its thermal stability when heated in contact with the air. Fatty acids are much less stable than glycerides, hence the smoke points of ordinary oils depend principally upon their content of free fatty acids. The melting point was 13±1.0°C, significantly lower than range reported for selected Nigerian oil seed (34.0±3.5-72.0±2.6°C)[10]. Since melting point decrease with increase in the degree of unsaturation[10], the lower melting point oils may be useful in the manufacture of soft and easy-to- digest margarine and have be shown to be valuable in the manufacture of oil creams. The setting point was 25.30±1.20°C which was within the range reported for some selected Nigerian oil seeds (4.67±0.30-26.30±1.50)°C [10].

Table-3, presents the fatty acid composition of dikanut *(Irvingia gabonensis).* The following fatty acids were found in the following percentage lauric acid (39.40±0.5), myristic acid (20.50±0.3), stearic acid (11.40±0.1), palmitic acid (10.30±0.2), oleic acid (6.90±0.2) and linolenic acid (6.40±0.2). The sample was richer than *Citrullus lanatus* seed-linolenic acid (5.29), stearic acid (8.33), but comparable in palmitic acid (10.57), and lower in terms oleic acid (13.65)[17]. Several authors reported that *Irvingia gabonensis* seed kernels oil may be regarded as myristic-lauric oil because myristic acid was most abundant, followed by lauric acid[7], but in this study the reverse was the case lauric was the most abundant followed myristic, thus, it may be regarded as lauric- myristic oil.

Conclusion

Taken as a whole, in this study, the physicochemical characteristics can be helpful to identify the quality of oil and oil products for possible industrial or commercial uses. The oil extracted, is saturated, a source of lauric and myristic acid, which is the characteristics of vegetable oils. From the quality point of view, *Irvingia gabonensis* seed oil classified as lauric-myristic oils, is comparable to other oils and can be utilized for both industrial and domestic purpose. The oil has a considerable high quality and good shelf life.

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