



## Effects of Extracting Solvents on the Physicochemical Properties of *Alchornea cordifolia*, *Hura crepitans*, *Irvingia gabonensis* and *Pycnanthus angollensis* Oils

Michael Akomaye Akpe<sup>1\*</sup> and Faith Patrick Inezi<sup>1</sup>

<sup>1</sup>Department of Chemistry, University of Calabar, Calabar, Nigeria.

### Authors' contributions

This work was carried out in collaboration between both authors. Author MAA designed the study and managed the analyses of the study. Author FPI managed the literature searches. Both authors read and approve the manuscript.

### Article Information

DOI: 10.9734/AJOCS/2020/v7i319022

#### Editor(s):

(1) Dr. Fahmida Khan, National Institute of Technology, Raipur, India.

#### Reviewers:

- (1) Ioniță Lucian, Romania.  
(2) Alexandre Ricardo Pereira Schuler, Universidade Federal de Pernambuco, Brazil.  
(3) Joanna Bryś, Warsaw University of Life Sciences, Poland.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/55355>

Received 10 January 2020

Accepted 15 March 2020

Published 31 March 2020

Original Research Article

### ABSTRACT

**Aims and Objectives:** To determine the effect of extracting solvents on the physicochemical properties of oils extracted from four locally available plant seeds in Nigeria namely: *Alchornea cordifolia*, *Hura crepitans*, *Irvingia gabonensis* and *Pycnanthus angollensis* using three different solvents namely; n-Hexane, Petroleum ether and Dichloromethane.

**Place and Duration of Study:** Department of Chemistry Laboratory, University of Calabar, Nigeria. The study was carried out between August 2019 and December 2019, (5 months).

**Methodology:** Each plant seed was ground into a paste and extracted for its oil using a Soxhlet extractor and three different solvents namely; n-Hexane, Petroleum ether and Dichloromethane. The physicochemical properties of the oils were then analysed.

**Results:** The results revealed the mean values of the physicochemical properties of *A. cordifolia* oil extracted using Hexane, Petroleum ether and Dichloromethane respectively were % yield (36.50, 34.50 and 32.00), specific gravity (0.91, 0.91 and 0.92), flash point (156.00, 155.00 and 191.00°C),

\*Corresponding author: E-mail: akomayeakpe2015@gmail.com;

Acid value (23.76, 25.10 and 26.80 mEqk<sup>-1</sup>), % free fatty acid (11.88, 12.55 and 13.40), Peroxide value (6.56, 6.38 and 6.90 mEqk<sup>-1</sup>), Saponification value (163.20, 156.40 and 165.50 mgKOHg<sup>-1</sup>) and iodine value (25.40, 48.60 and 46.50 g/100 g). The mean values of the properties of *H. crepitans* oil across the 3 solvents respectively were % yield (32.20, 31.50 and 29.00), specific gravity (0.92, 0.93 and 0.94), flash point (271.00, 259.00 and 240.00°C), Acid value (21.00, 21.80 and 22.20 mEqk<sup>-1</sup>), % free fatty acid (10.50, 10.90 and 11.10), Peroxide value (5.85, 6.26 and 7.10 mEqk<sup>-1</sup>), Saponification value (172.50, 190.40 and 185.60 mgKOHg<sup>-1</sup>) and Iodine value (43.60, 34.50 and 26.90 g/100 g). Properties of the *I. gabonensis* oil were % yield (33.20, 34.00 and 32.50), Specific gravity (0.92, 0.94 and 0.94), flash point (230.00, 236.00 and 260.00°C), Acid value (3.72, 3.70 and 3.90 mEqk<sup>-1</sup>), % free fatty acid (1.86, 1.85 and 1.95), Peroxide value (2.98, 4.26 and 3.63), Saponification value (239.50, 252.40 and 245.80) and Iodine value (25.30, 11.70 and 44.20). Mean values of *P. angollensis* oil properties were % yield (34.10, 36.20 and 33.00), Specific gravity (0.92, 0.92 and 0.93), flash point (260.00, 258.00 and 256.00°C), Acid value (23.68, 25.00 and 26.00 mEqk<sup>-1</sup>), % free fatty acid (11.84, 12.50 and 13.00), Peroxide value (4.25, 5.30 and 5.96), Saponification value (25.30, 52.50 and 57.30) and Iodine value (25.20, 11.68 and 44.40). The odour, colour and physical state of all the oils at room temperature was the same across the 3 solvents.

**Conclusion:** The results indicate that the physicochemical properties of the oils vary with the extracting solvent and its polarity. Their properties revealed that some of them can be used for many domestic and industrial purposes especially for the making of paints, soap, cosmetics, lubricants and varnishes.

**Keywords:** *Extracting solvents; Alchornea cordifolia; Hura crepitans; Irvingia gabonensis; Pycnanthus angollensis; seed oils.*

## 1. INTRODUCTION

Vegetable oils are used for both domestic and industrial purposes all over the world based on their physical and chemical properties [1]. Ancient Egyptians originally produced infusions of medicinal or aromatic plants vegetable oils as servants for therapeutic, nutritional, aesthetic and spiritual purposes. The oils were used for the production of cosmetics providing emollients, moisturizers and grooming, or as solvents/vehicles to carry other agents [2]. Palm kernel oil is one of the most commonly used vegetable oils because its properties have been studied and known that it is good for soap making and the production of cosmetics, paints, varnishes industrially based on its saponification value, iodine value etc [3]. Besides, while some of these oils are used for the production of commodities like soaps, cosmetics, paints, varnishes, lubricants plastics, others are used for cooking or are prepared and eaten in form of butter or margarine. According to Ekpa [4], some vegetable oils are now used as substitutes for petrol or diesel as fuel in automobiles in the form of biodiesel or bioethanol. Medicinally, many vegetable oils have healing properties. Ihesie [5] have reported that sesame seed oil can be used to treat health problems like chronic constipation in elders, round worms in children, dysmenorrhoea (painful menstruation) in women,

amenorrhoea, asthmatic symptoms, coughs and hiccoughs, and insufficient flow of breast milk in nursing mothers by the oral intake of the oil up to two tea spoons at a time. Based on the facts so far presented, the importance of vegetable oils to man cannot be over emphasized and their economic value unquantifiable. Physicochemical (physical and chemical) properties of oils determine their quality, uses or application and the economic value. These properties also depend on the source of the vegetable oil (i.e. type of plant) and the method of extracting or tapping the oil from the plant seed or material. Several methods like milling/pressing, water/steam extraction and solvent extraction have been used to extract oils from plants sources. Ikya [6] have studied the effect of extraction methods on physicochemical properties of Shea butter oil and reported that differences in physical and chemical properties exist in the oil extracted by solvent extraction and traditional methods. However, effect of different extracting solvents on the physicochemical properties of vegetable oils has not been critically studied. Consequently, this study is aimed at determining the effect of different extracting solvents on the physicochemical properties of oils extracted from *Alchornea cordifolia* (Christmas bush), *Hura crepitans* (Sand box seed), *Irvingia gabonensis* (Bush mango seed) and *Pycnanthus angollensis* (Illomba seed)

which are found locally in Obudu Area of Cross River State and many other parts of Nigeria using three (3) different solvents namely; n-Hexane, Petroleum ether and Dichloromethane.

## 2. MATERIALS AND METHODS

**Sample collection and preparation:** Viable or healthy seeds of *Alchornea cordifolia* (Christmas bush), *Hura crepitans* (sand box seed), *Irvingia gabonensis* (Bush mango seed) and *Pycnanthus angolensis* (illomba seed) were collected locally from Obudu Area of Cross River State of Nigeria between February and March, and were taken to the Department of Botany, University of Calabar for identification of botanical names and labeling. The samples were then taken to the Chemistry Department of the same University where their shells were removed (where applicable), sun dried for several days, wrapped in polythene bags and kept for use within one month. Each sample was crushed or ground into a paste using a manual grinding machine. 100 g of the paste of each sample was packed in an ash less filter paper and placed in the thimble of a Soxhlet apparatus (extractor) and extracted using N-hexane, Petroleum ether and Dichloromethane as extracting solvents. At the end of the continuous extraction for about 5 to 6 hours, the extracting solvent was evaporated off leaving the oil sample for analysis. The percentage yield of the oil extract of each sample was determined thus:

$$\% \text{ yield} = \frac{\text{weight of oil}}{\text{weight of sample}} \times 100\%$$

**Sample analysis:** The specific gravity of the oils was determined according to the method reported by Onwuka [7] thus: A 50 mL pycnometer bottle was washed with water and detergent, rinsed and dried. The bottle was filled with distilled water and weighed. After drying the bottle of water, it was filled with the oil sample and weighed. The specific gravity was calculated thus:

$$\text{Specific gravity} = \frac{\text{weight of 50mL of oil}}{\text{weight of 50mL of water}}$$

The colour, state at room temperature and the odour were observed and perceived using the human sense organs. The flash point of the oil samples was determined following the procedure reported by Onwuka [7] thus: 10 mL of the oil was poured into an evaporating dish and placed

on a source of heat. A thermometer was suspended at the centre of the dish ensuring that its bulb dips inside the oil without touching the bottom of the dish. The temperature of the oil was raised gradually by regulating the source of heat. The point at which the oil began to give off a thin bluish smoke continuously (i.e. smoke point), a flame was applied using a match-stick. The temperature at which the oil started flashing when the flame is applied without supporting combustion was noted as the flash point of the oil.

The acid value was determined following the method of AOAC [8] as reported by Onwuka [7] thus: 1.0 g each of the oils was dissolved in a mixture obtained by mixing 25 mL diethylether and 25 mL ethanol, and titrated with 0.1M NaOH using phenolphthalein as an indicator, shaking till a pink colour end point which persisted for 15 seconds was observed. The acid value and % free fatty acids were calculated as follows:

$$\text{Acid Value} = \frac{\text{Titre volume(mL)} \times 56.1 \times M}{\text{weight of sample}}$$

Where, M is the molarity of NaOH (0.1M).

Acid value is expressed in milliequivalent per kilogramme ( $\text{mEqkg}^{-1}$ ).  $\% \text{ free fatty acid} = \frac{1}{2} \times \text{Acid value}$

The saponification value was determined using the method of AOAC [8] as reported by Onwuka [7] thus: 1 gram of the oil was weighed into a round bottom flask and 24 mL of alcoholic potassium hydroxide solution was added. A reflux condenser was attached to the flask and heated on a sand bath for 1 hour shaking frequently. One mL of phenolphthalein (1%) solution was added and titrated while hot with 0.5M HCl to a colourless end point. A blank titration was also carried out the volume at end point recorded. The saponification value was calculated thus:

$$\text{Saponification value} = \frac{(X - Y) \times 56.1 M}{\text{Weight of sample}}$$

Where X = volume (mL) of test solution titration  
Y = volume (mL) of blank titration  
M = Molarity of HCl (0.5)

The peroxide value was determined using the method of AOAC [8] as described by Onwuka [7] thus: 1 ml of potassium iodide (KI) was added to

20 mL of a solution of mL of (2:1) volumes of glacial acetic acid and chloroform. The result out solution was added to 1.0 g of the oil sample in a clean dry conical flask. The mixture was left in a dark for about 2 minutes and 30 mL of distilled water was added and titrated with 0.02M sodium thiosulphate solution using 5 mL starch as indicator. A blank titration was also carried out. The peroxide value was calculated thus:

$$\text{Peroxide value} = (100M (Va - Vb))/W$$

Where W = weight of oil sample

Va = volume in mL of thiosulphate used in test solution

Vb = volume in mL of thiosulphate used in blank solution

M = molarity of sodium thiosulphate (0.02).

The iodine value was determined using Wij's method as described by Onwuka [7] thus: 0.5 g of the oil samples were poured into a beaker and 10 ml of carbon tetrachloride was added, 20 mL of Wij's solution was added and a stopper previously moisten with potassium iodide was inserted and allowed to stand in the dark for 30 minutes. 15 mL of potassium iodide solution (10%) was added and titrated with 0.1M sodium thiosulphate solution using starch as indicator. A blank titration was also carried out. The iodine value was calculated thus:

$$\text{Iodine value} = \frac{(b - a) \times 12.69M}{\text{weight of sample}}$$

Where a = volume in mL of test titration

b = volume in mL of blank titration

M = molarity of thiosulphate (0.1)

### 3. RESULTS

The results of the physical and chemical properties are presented in Tables 1A-4A and 1B-4B respectively.

### 4. DISCUSSION

The results in Table 1A for physical properties of *A. cordifolia* revealed that the % yield decreases from 36.50 in Hexane to 32.00 in Dichloromethane with increasing polarity, while flash point increases with polarity 156.00 in Hexane to 191.00 in Dichloromethane. Other physical properties did not significantly change with the polarity of the solvents. In Table 1B, the chemical properties tend to increase steadily with

polarity from Hexane to Dichloromethane except the saponification value that was (165.50) highest in Dichloromethane but (156.40) lowest in Petroleum ether, and iodine value that was (48.60) highest in Petroleum ether but (25.40) lowest in Hexane. The variation in these properties could be due to the nature of the fatty acid composition of the oil (i.e. either saturated or unsaturated) and the polarity of the solvents.

For *H. crepitans* oil, the results in Table 2A showed that the % yield decreases from 32.20 in Hexane to 29.00 in Dichloromethane and the flash point decreases from 271 in Hexane to 240 in Dichloromethane, while the specific gravity increases with increase in polarity. Other physical properties remain the same across the 3 solvents. The results in Table 2B showed that iodine value decreases with increase in polarity from Hexane (43.60) to Dichloromethane (26.90), while saponification value increases with polarity from Hexane (172.50) to Petroleum ether (190.40) and decrease slightly with polarity to 185.60 in Dichloromethane. Acid value, % free fatty acid and peroxide value increased slightly with increase in polarity from Hexane to Dichloromethane. The cause of the variation in the oil properties may also be due to the degree of polarity of the solvents and the fatty acid composition of the oil.

For *I. gabonensis* oil, the data in Table revealed that the flash point and specific gravity increases with increase in polarity from Hexane to Dichloromethane, while % yield increased from Hexane (33.20) to Petroleum ether (34.00) but decreased slightly to 32.50 in Dichloromethane. Colour, odour and physical state at room temperature were unaffected in the different solvents. In Table 3B, acid value decreased insignificantly from 3.72 in Hexane to 3.70 in Petroleum ether but increased to 3.90 in Dichloromethane, likewise the % free fatty acid. Peroxide value increased with polarity from 2.98 in Hexane to 4.26 in Petroleum ether but decreased from 3.63 in Dichloromethane. Saponification value also increased from 239.50 in Hexane to 252.40 in Petroleum ether but decreased to 245.80 in Dichloromethane. Iodine value decreased with polarity from 25.30 in Hexane to 11.70 in Petroleum ether but increased to 44.20 in Dichloromethane. The changes in the oil properties across the solvents could be as result of the increase in polarity from Hexane to Dichloromethane the chemical nature of the fatty acids of the oil.

**Table 1A. Physical properties of *Alchornea cordifolia* seed oil extracted using three (3) different solvents**

Properties	N-Hexane	Petroleum ether	Dichloromethane
% Yield	36.50±1.50	34.50±1.20	32.00±1.50
Specific gravity	0.91±0.01	0.91±0.01	0.92±0.02
Flash point (°C)	156.00±2.00	155.00±1.50	191.00±2.00
State at 25-30°C	Liquid	Semi-solid	Semi-solid
Colour	Reddish	Reddish	Reddish
Odour	Non-offensive	Non-offensive	Non-offensive

**Table 1B. Chemical properties of *Alchornea cordifolia* seed oil extracted using three (3) different solvents**

Properties	N-Hexane	Petroleum ether	Dichloromethane
Acid Value (mEqK <sup>-1</sup> )	23.76±1.24	25.10±1.30	26.80±2.10
%Free Fatty acid	11.88±1.12	12.55±0.75	13.40±1.10
Peroxide Value(mEqK <sup>-1</sup> )	6.56±0.13	6.38±0.14	6.90±0.13
Saponification Value (mgKOHg <sup>-1</sup> )	163.20±2.30	156.40±2.60	165.50±1.50
Iodine Value (g/100g)	25.40±1.40	48.60±2.30	46.50±2.20

**Table 2A. Physical properties of *Hura crepitans* seed oil extracted using three (3) different solvents**

Properties	N-Hexane	Petroleum ether	Dichloromethane
% Yield	32.20±2.50	31.50±2.10	29.00±2.00
Specific gravity	0.92±0.02	0.93±0.01	0.94±0.01
Flash point (°C)	271.00±2.00	259.00±3.00	240.00±2.00
State at 25-30 °C	Liquid	Liquid	Liquid
Colour	Pale yellow	Pale yellow	Pale yellow
Odour	Non-offensive	Non-offensive	Non-offensive

**Table 2B. Chemical properties of *Hura crepitans* seed oil extracted using three (3) different solvents**

Properties	N-Hexane	Petroleum ether	Dichloromethane
Acid Value (mEqK <sup>-1</sup> )	21.00±1.02	21.80±1.20	22.20±1.10
%Free Fatty acid	10.50±1.00	10.90±1.05	11.10±1.05
Peroxide Value (mEqK <sup>-1</sup> )	5.85±0.24	6.26±0.14	7.10±0.15
Saponification Value (mgKOHg <sup>-1</sup> )	172.50±2.50	190.40±2.20	185.60±2.10
Iodine Value (g/100g)	43.60±2.10	34.50±2.50	26.90±1.40

**Table 3A. Physical properties of *Irvingia gabonensis* seed oil extracted using three (3) different solvents**

Properties	N-Hexane	Petroleum ether	Dichloromethane
% Yield	33.20±2.30	34.00±1.50	32.50±2.50
Specific gravity	0.92±0.02	0.94±0.01	0.94±0.02
Flash point (°C)	230.00±2.00	236.00±3.00	260.00±2.00
State at 25-30 °C	Waxy solid	Waxy solid	Waxy solid
Colour	Milky white	Milky white	Milky white
Odour	Non-offensive	Non-offensive	Non-offensive

**Table 3B. Chemical properties of *Irvingia gabonensis* seed oil extracted using three (3) different solvents**

Properties	N-Hexane	Petroleum ether	Dichloromethane
Acid Value (mEqk <sup>-1</sup> )	3.72±0.15	3.70±0.05	3.90±0.10
%Free Fatty acid	1.86±0.02	1.85±0.01	1.95±0.05
Peroxide Value (mEqK <sup>-1</sup> )	2.98±0.02	4.26±0.21	3.63±0.20
Saponification Value (mgKOHg <sup>-1</sup> )	239.50±3.10	252.40±2.60	245.80±2.20
Iodine Value (g/100g)	25.30±1.20	11.70±1.30	44.20±2.30

**Table 4A. Physical properties of *Pycnanthus angollensis* seed oil extracted using three (3) different solvents**

Properties	N-Hexane	Petroleum ether	Dichloromethane
% Yield	34.10±2.10	36.20±2.30	33.00±2.00
Specific gravity	0.92±0.02	0.92±0.01	0.93±0.01
Flash point (°C)	260.00±2.00	258.00±2.00	256.00±2.00
State at 25-30 °C	Waxy solid	Waxy solid	Waxy solid
Colour	Reddish brown	Reddish brown	Reddish brown
Odour	Non-offensive	Non-offensive	Non-offensive

**Table 4B. Chemical properties of *Pycnanthus angollensis* seed oil extracted using three (3) different solvents**

Properties	N-Hexane	Petroleum ether	Dichloromethane
Acid Value (mEqk <sup>-1</sup> )	23.68±1.20	25.00±1.50	26.00±2.00
%Free Fatty acid	11.84±0.60	12.50±1.00	13.00±1.00
Peroxide Value (mEqK <sup>-1</sup> )	4.25±0.20	5.30±0.25	5.96±0.24
Saponification Value (mgKOHg <sup>-1</sup> )	25.30±2.20	52.50±2.50	57.30±2.70
Iodine Value (g/100g)	25.20±1.30	11.68±0.32	44.40±2.10

For *P. angollensis* oil, the results in Table 4A showed that the % yield increased with polarity from 34.10 in Hexane to 36.20 in Petroleum ether but decreased to 33.00 in Dichloromethane. The flash point decreased with polarity from 260 in Hexane to 256 in Dichloromethane. The specific gravity was the same (0.92) in Hexane and Petroleum ether but increased slightly with polarity to 0.93 in Dichloromethane, while other physical properties were the same in the three solvents. In Table 4B, the Acid value increased with polarity from 23.68 in Hexane to 26.00 in Dichloromethane, likewise the % free fatty acid. Peroxide value increased with polarity from 4.25 in Hexane to 5.96 in Dichloromethane. Saponification value also increased from 25.30 in Hexane to 57.30 in Dichloromethane. Iodine value decreased with polarity from 25.20 in Hexane to 11.68 in Petroleum ether but increased greatly to 44.40 in Dichloromethane. All these variations could be due to the degree of polarity of the solvents or the difference in the polar atoms (oxygen and chlorine) and the composition of fatty acids in the oil and their degree of unsaturation. The effect of the polarity of extracting solvent on the

quality or quantity of vegetable oils has been supported by Attah and Ibemesi [9]. Besides, the ratio or percentage composition of saturated fatty acid to the unsaturated fatty acids in oil can affect its properties. This ratio could depend on the type of fatty acids a particular extracting solvent can extract from the plant or vegetable seed or nut based on its polarity or affinity for the acids. From the results obtained above, the physicochemical properties of the oils tend to vary with the extracting solvent used. The order of variation for flash point, Acid value, saponification value, peroxide value, specific gravity and flash point in most cases was Dichloromethane > petroleum ether > hexane, % yield was in the order Hexane > petroleum ether > dichloromethane, while for iodine value it was Dichloromethane > hexane > petroleum ether.

The percentage yield of all the oils across the 3 solvents is higher than the commonly used palm kernel oil with a % yield of 28% as reported by Akubugwo and Ugborgu [3]. Thus, the 3 seed plants can be used as good sources of vegetable oil.

The flash point is the temperature at which volatile evolving from the heated oil will flash but not support combustion. It measures the thermal stability of the oil [7]. It is also an indicator for the suitability of the oil for frying [10]. These results indicate that *I. gabonensis* oil is better frying oil and more thermally stable oil than the other 3 oils due to its high flash point values across the extracting solvents.

The specific gravity (relative density) values of the oils across the extracting solvents were all higher than 0.88 reported for palm kernel oil by Akubugwo and Ugborgu [3], which is commonly used industrially. All the oil samples were non-offensive in their odour, bright, attractive and appealing in colour and their state at room temperature was the same in all the extracting solvents.

The acid values and % free fatty acids values of the oils vary across the different extracting solvents. Acid value is an indicator for edibility of oil and suitability for use in the paint industry. *I. gabonensis* oil is the only oil directly edible in all the solvents, going by its free fatty acid value of less than 3 [11] as cited by Akpe [10]. It can also compete favorably with sesame, soya bean, sun flower and rapeseed oils with acid value of about 4 as reported by Pearson [12]. Its values compete favourably with CODEX Standard Acid values for cold pressed palm oil and virgin palm oil which are 4.0 and 10.0 mgKOH/g respectively, and are consumed directly [13].

The peroxide value is an indicator for the deterioration of oils. Fresh oils have values less than 10 mEqkg<sup>-1</sup> and rancid oils have values ranging from 20 to 40 [7]. It is also an indicator for longer and shorter shelf life during storage, as fresh oils last longer [14]. Thus, all the 4 seed oils extracted using the three solvents are fresh oils and they compete favourably with 2.12 mEqKg<sup>-1</sup> reported for PKO by Akubugwo and Ugborgu [3].

The saponification value is an indication that the oils have potential for use in the industry when values are high especially for soap and cosmetics [15]. Its values vary across the 3 solvents for all the oils. *I. gabonensis* with values ranging from 239 to 252 has good potential for industrial use and compete with PKO that has a value of 246.60 [3].

The Iodine values of the oils across the 3 solvents indicates that all the three oils are non-drying oils because their values are less than 100, those with values between 100 and 150 are semi-drying oils while those greater than 150 are drying oils [16]. This non-drying character qualifies them for use in the paint industry [17]. However, the oils compete favorably with PKO which is also non-drying oil with an iodine value of 18.30 as stated by Akubugwo and Ugborgu [3].

The physicochemical properties of the four seed oils studied compete favorably with palm kernel oil (PKO) and conventional seed oils like groundnut oil, soya bean, rapeseed, castor seed etc.

## 5. CONCLUSION

At the end of this study, the 4 oil seeds can be classified as high yielding based on the % yield. *I. gabonensis* is suitable for direct consumption by its free fatty acid value. Their iodine and saponification values show they are suitable for the industrial production of soaps, cosmetics, paints etc. Their colours are bright and attractive while their odours are non-offensive. Most of the physicochemical properties of the four seed oils studied compete favorably with palm kernel oil (PKO) and conventional seed oils like groundnut oil, soya bean, rapeseed, castor seed etc. The physicochemical properties vary slightly with the extracting solvent used. Petroleum ether and dichloromethane seem to extract oil with higher Acid value, saponification value, peroxide value, specific gravity and flash point than hexane in most of the oil seeds. Dichloromethane extracted oil with higher iodine value than hexane and petroleum ether. Hexane on the other hand extracted oil with higher % yield than petroleum ether and dichloromethane. One can therefore recommend that for high % yield, hexane should be used among the three solvents, for Acid value, saponification value, peroxide value, iodine value, specific gravity and flash point, dichloromethane should be used among the three solvents, and that the 4 seed oils have potentials for development and use for domestic and industrial purposes.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Akpe MA, Inezi F. Physicochemical properties of *Alchornea cordifolia*, *Cyperus esculentum* and *Irvingia gabonensis* seed oils and their applications. Asian Journal of Applied Chemistry Research. 2018;1:1-7.
2. Berdick M. The role of fats and oils in cosmetics. Journal of American Oil Chem. Soc. 1972;49:406-408.
3. Akubugwo IE, Ugborgu AE. Physicochemical studies on oils from five selected Nigerian plant seeds. Pakistan Journal of Nutrition. 2007;6(1):75-78.
4. Ekpa OD. Entrepreneurial chemistry: A Chemist's approach to wealth creation in a depressed economy. 43<sup>rd</sup> Inaugural Lecture University of Calabar, Calabar; 2008.
5. Ihesie G. Medicinal uses of sesame oil. Saturday Vanguard. 2008;29:44-45.
6. Ikya JK, Umenger LN, Ayangealumun I. Effects of extracting methods on the yield and quality characteristics of oils from Shea nut. Journal of Food Resource Science. 2013;2(1):1-12.
7. Onwuka GA. Food analysis and instrumentation; Theory and practice. Naphthali Prints, Lagos, Nigeria; 2005.
8. AOAC. Official methods of analysis: 4<sup>th</sup> Ed. Association of Official Analytical Chemists; V.A. Arlington; 1984.
9. Attah JC, Ibemesi JA. Solvent extraction of the oils of rubber, melon, pumpkin and oilbean seeds. Journal of the American Oil Chemists Society. 1990;67(1):25-27.
10. Akpe MA, Oyo-lta I, Dosunmu MI. Analysis of the physicochemical properties of *Carica papaya*, *Citrus paradisi* and *Croton zambesicus* seed oils and their applications. World Journal of Research and Review. 2018;6(2):6-8.
11. Eckey EW. Vegetable fats and oils. Reinhold; New York; 1954.
12. Pearson D. The chemical analysis of food. Churchill, Livingstone; 1976.
13. Codex-Stan210. Codex standard for fats and oils from vegetable sources. Codex Stand-Food and Agriculture Organisation; 1999.
14. Eka OU. Proximate composition of bush mango tree and some properties of Dika fat. Nig. J. Nutri. Sci. 1980;133-36.
15. Amoo IA, Eleyinmi AF, Oilaboye NA, Akoja SS. Characteristics of oil extract from gourd (*Cucurbita maxima*). Seed Food, Agriculture and Environment. 2004;2:38-39.
16. Schwartz TA, Bunce MD, Silberman RG, Stanizki CI, Starlton WJ, Zipp AP. Chemistry in context. 2<sup>nd</sup> Edition: U.S.A, McGraw-Hill Companies Inc; 1997.
17. Dosunmu MJ, Ochu C. Physicochemical properties and fatty acid composition of lipids extracted from some Nigeria fruits and seeds. Global J. Pure and Applied Sci. 1995;1:45-47.

© 2020 Akpe and Inezi; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:  
The peer review history for this paper can be accessed here:  
<http://www.sdiarticle4.com/review-history/55355>