

Physicochemical Properties of *Hura crepitans* and *Pycnanthus angolensis* Seed Oils and Their Possible Uses

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Abstract

The physicochemical properties of oils extracted from two locally available plant seeds in Obudu in Cross River State, Nigeria namely; *Hura crepitans* and *Pycnanthus angolensis* using n-Hexane were determined. The results of the analysis revealed that their % yield were 32.50 and 34.00 for *Hura crepitans* and *Pycnanthus angolensis* respectively. Their odour was non-offensive and their colour bright and attractive. The specific gravity of the oils was 0.93 and 0.92 for *H. crepitans* and *P. angolensis* respectively. Their flash points in °C were also 272 and 260 respectively, indicating that both oils are thermally stable oil and suitable for frying. The chemical properties for *H. crepitans* and *P. angolensis* respectively were as follows: Acid values in mEqKg⁻¹ were 20.90 and 23.66. Peroxide values in mEqKg⁻¹ were 10.45 and 11.83. Saponification values were 171.11 and 35.25. Iodine values were 44.16 and 25.25. These results indicate that the two seeds are viable sources of oil based on their % yield. They are good for both domestic and industrial use based on their acid, saponification and iodine values. Their properties in most cases compete favorably with palm kernel oil (PKO) which is currently being used for many industrial purposes in Nigeria especially for the making of paints, soap, cosmetics and varnishes.

Keywords: Physicochemical Properties, Seed oils, Uses.

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INTRODUCTION

Oil from plants is used for both domestic and industrial purposes all over the world based on its physical and chemical properties. Palm kernel oil is one of the most commonly used vegetable oils because its properties have been studied and known especially by researchers like Akubugwo and Ugboru, stating that is good for soap making and the production of cosmetics, paints, varnishes industrially based on its saponification value, iodine value etc [1]. According to Unilever Plc, vegetable oils from plants like oil palm tree, groundnut, olive, beniseed (*sesame*), soya beans, coconut, castor seed, linseed etc. plays an important role in our diet as a source of fat and oil, a major class of food required for warmth and energy in the body [2]. Besides, some of these oils are used for the production of commodities like soaps, cosmetics, paints, varnishes, lubricants plastics, while others are used for cooking or are prepared and eaten in form of butter or margarine. Moreover, some vegetable oils are now used as substitutes for petrol or diesel as fuel in automobiles in the form of biodiesel or bio-ethanol [3]. Medicinally, Ihesie have reported that sesame seed oil can be used to treat health problems like chronic constipation in elders, round worms in children, dysmenorrhea (painful

menstruation) in women, amenorrhea, 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 [4]. Akpe have also studied the physicochemical properties of *Carica papaya*, *Citrus paradisi* and *Croton zambesicus* seed oils and reported that they compete favorably with palm kernel oil used for several industrial purposes in Nigeria [5]. Based on the facts so far, the importance of vegetable oils to man cannot be over emphasized and their economic value unquantifiable. However, one can observed that the oil plants or crops mentioned above are a small percentage of the several hundreds of plants in nature whose oil potentials have not been discovered, even some that have been identified as oil seed crops are being underutilized because their oil properties and potentials have not been properly studied to ascertain their suitability for use domestically and or industrially. Consequently, this study is aimed at determining the physicochemical properties of oils extracted from *Hura crepitans* (Sand box seed) and *Pycnanthus angolensis* (Illomba seed) which are found locally in Obudu Area of Cross River State and many other parts of Nigeria and have not been properly studied. This is with a view to determine their potentials and properties as sources of vegetable oil for domestic and industrial uses, and

also compare their properties with the established properties of palm kernel oil from *Elaeis guinensis* (palm tree) which is popularly in use now.

MATERIALS AND METHOD

Sample Collection and Preparation

Viable or healthy seeds of *Hura crepitans* (sand box 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 they were shelled or de-hulled (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. 100g 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 as the extracting solvent. 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 [6] 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 [6] 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 [7] as reported by Onwuka [6] thus:

1.0g 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 (mEqkg⁻¹). $\% \text{ free fatty acid} = \frac{1}{2} \times \text{Acid value}$

The saponification value was determined using the method of AOAC [7] as reported by [6] 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 [7] as described by [6] 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 30mL 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:

$$\text{Peroxide value} = (100M (V_a - V_b)/W$$

Where,

W = weight of oil sample
V_a = volume in mL of thiosulphate used in test solution
V_b = 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 [6] thus: 0.5g of the oil

samples were poured into a beaker and 10ml 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. 15mL 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:

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

Table-1: Physical properties of *Hura crepitans* and *Pycnanthus angollensis* seed oils

Physical property	<i>Hura crepitans</i>	<i>Pycnanthus angollensis</i>
% Yield	32.50 ± 2.15	34.00 ± 2.50
Specific gravity	0.93 ± 0.01	0.92 ± 0.02
Flash point (°C)	272.00 ± 3.50	260 ± 2.50
State at 25 °C (Room temperature)	Liquid	Waxy solid
Colour	Light yellow	Reddish brown
Odour	Non-offensive	Non-offensive

Values reported in mean ± SD, with N = 3

Table-2: Chemical properties *Hura crepitans* and *Pycnanthus angollensis* seed oils

Chemical property	<i>Hura crepitans</i>	<i>Pycnanthus angollensis</i>
Acid value in mEqkg ⁻¹	20.90 ± 1.04	23.66 ± 1.35
% Free fatty acids	10.45 ± 1.03	11.83 ± 1.15
Peroxide value	5.86 ± 0.23	4.26 ± 0.22
Iodine value	44.16 ± 2.00	25.25 ± 1.36
Saponification value	171.11 ± 2.30	35.25 ± 2.00

Values reported in mean ± SD, with N = 3

DISCUSSION

The percentage yield in Table-1 revealed that *Hura crepitans* has 32.50% while *Pycnanthus angollensis* has 34.00%. This shows that *H. crepitans* has higher %yield than *P. angollensis*. However, these values compete favorably with palm kernel oil with a % yield of 28% as reported by Akubugwo and Ugborgu [1]. Thus, the 2 seed plants can be considered as viable sources of vegetable oil.

The flash point is the temperature at which volatiles evolving from the heated oil will flash but not support combustion. It measures the thermal stability of the oil [6]. It is also an indicator for the suitability of the oil for frying [5]. The results in Table 1 showed that the flash points in °C were 272 and 260 for *H. crepitans* and *P. angollensis* respectively. These results indicate that *H. crepitans* oil is slightly better frying oil and a more thermally stable oil than *P. angollensis*. However, both oils are thermally stable and suitable for frying based on their high flash point values.

The specific gravity (relative density) of the oils were 0.93 and 0.92 for *H. crepitans* and *P. angollensis* respectively, all higher than 0.88 reported for palm kernel oil by Akubugwo and Ugborgu [1], which is commonly used industrially. All the oil samples were non-offensive in their odour. *H. crepitans* was light yellow in colour while *P. angollensis* was reddish-brown in colour. This makes the oils attractive

Where,

a = volume in mL of test titration

b = volume in mL of blank titration

M = molarity of thiosulphate (0.1)

RESULTS

The results of the physical and chemical properties are presented in Table 1 and 2 respectively

and appealing. Their state at room temperature was liquid and waxy solid for *H. crepitans* and *P. angollensis* respectively. *P. angollensis* also compete with palm kernel oil (PKO) which is semi-solid as reported by Akubugwo and Ugborgu [1].

The chemical properties of the studied oils are reported in Table 2. The results showed that the acid values of the oils were 20.90 and 23.66 for *H. crepitans* and *P. angollensis* respectively. Also, the % free fatty acids were 10.45 and 11.83 for *H. crepitans* and *P. angollensis* respectively. All these values are higher than PKO with an acid value of 14.04 [1]. Acid value is an indicator for edibility of oil and suitability for use in the paint industry. *H. crepitans* and *P. angollensis* oil are not edible going by their free fatty acid value of greater than 3 [8]. Sesame, soya bean, sun flower and rapeseed oils with acid value of about 4 are edible as reported by Pearson [9]. Thus, the two oils with the least acid value cannot be consumed directly except after alkaline refining.

The peroxide values of the oils were 5.86 and 4.26 for *H. crepitans* and *P. angollensis* respectively. It is an indicator for the deterioration of oils. Fresh oils have values less than 10 mEqkg⁻¹ and rancid oils have values ranging from 20 to 40 [6]. It is also an indicator for longer and shorter shelf life during storage, as fresh oils last longer [10]. Thus, all the 2 seed oils are fresh

oils and compete favorably with PKO reported by Akubugwo and Ugborgu [1].

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 [11]. Its values for the oils were 171.11 and 35.25 for *H. crepitans* and *P. angollensis* respectively. *P. angollensis* with a higher value has potential for industrial use but both oils have values less than PKO with a value of 246.60 [1].

The Iodine values of the oils were 44.16 and 25.25 for *H. crepitans* and *P. angollensis* respectively. These values indicate 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 [12]. This non-drying character qualifies them for use in the paint industry [13]. However, the oils compete favorably with PKO which is also non-drying oil with an iodine value of 18.30 as stated by [1]. Based on their iodine values, the storage procedure should ensure protection from oxidative rancidity or deterioration as they contain appreciable level of unsaturated bonds.

CONCLUSION

At the end of this study, the 2 oil seeds can be classified as high yielding based on their % yield. *H. crepitans* and *P. angollensis* are not suitable for direct consumption by their free fatty acid value. Their iodine and saponification values shows that they have potentials for the industrial production of soaps, cosmetics, paints etc. especially *H. crepitans*. Their colours are bright and attractive while their odours are non-offensive. Most of the physicochemical properties of the two seed oils studied compete favorably with palm kernel oil (PKO). One can therefore recommend that the 2 seed oils have potentials for development and use for industrial purposes.

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