

Extraction and Characterization of Oil from African Locust Bean (*Parkia biglobosa*) Seed

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ABSTRACT

The extraction of oil from African locust bean seeds was carried out in this work. Standard procedures were followed to determine the yield present in the oil feed stocks using n-hexane in a Soxhlet extraction apparatus. Analyses were carried out to determine their proximate compositions and physicochemical characteristics. The determination of the functional groups and fatty acid compositions present in the extracted oils was also carried out using Fourier Transform Infrared Spectrophotometry (FTIR) and Gas Chromatography Mass Spectrophotometry (GC-MS) respectively. The results revealed that African locust bean seed has higher oil yield, crude fat, crude protein, ash content, crude fibre, moisture content than some other seeds such as Date palm seed with the exception of the carbohydrates content. Similarly, African locust bean seed oil which was yellowish brown in colour contained higher acid value, iodine value, peroxide value, free fatty acid with the exception of saponification value and specific gravity in comparison. Result from the FTIR analysis shows that 15 peaks were noticed in African locust bean seed oil, indicating the presence of various functional groups such as OH, C-H, C=C, C=O, $C\equiv C$ and C-N. Similarly, the GC-MS result also reveals that there are 6 dominating fatty acid compounds present in locust beans seed oil in relation to their relative weight composition abundance. In locust bean seed oil, linoleic acid stood out as the fatty acid compound with the highest weight composition of 31.9% having a relatively high degree of unsaturation. Furthermore, capric acid and lauric acid were found in this oil. Judging from all the results in this work, it can be deduced that African locust bean seed oil may serve as better alternative oil for consumption and in large-scale production of lubricants, cosmetics, paints, and hydraulic brake fluid.

Key Words: African Locust Beans Seed, extraction, oil yield, proximate properties, physicochemical properties, functional groups and fatty acids composition.

1.0 Introduction

The value that is attached to and edible oil bearing seeds is dependent on their nutritive and calorific content. The demand and use of seed oil is on the increase, giving it its place as an essential commodity in the global market (Odoemelam, 2005; Kyari, 2008). These oil bearing seeds are propagated by the activities of man and animals. The abundance of their oil content is relative, making some few to be commercially viable (Warra *et al.*, 2014). Attah (2003) opine

that, the factors that may be responsible for the difference in their oil content are the plant growing environment, the maturity of the seed and storage conditions. Some other attributing factors as mentioned by Cheikh-Rouhou *et al.* (2007) are variation in climate conditions and their genetic compositions stemming from natural or hybrid source. Some useful oil seed plants that can be use used for different purposes are soyabeans, jatropha plant, castor plant, African locust bean plant, date palm plant, just to mention a few. These can be use used for different purposes (Al-Farsi and Lee, 2007). Al-Hooti *et al.*, (1997) observed that nutritional value, free of defect, shape and size, colour and appearance, texture and flavor are criteria considered for their consumption by consumers.

African locust bean tree (*Parkia Biglobosa*) is a perennial tree which produces fruits in form of a pod containing yellow powdery pulp with seed embedded in it (Simonyan, 1988). Fermented locust bean seeds are used as spices in soup preparation in some African countries such as Nigeria, Togo, Ghana, Sierra lonne (Aremu *et al.*, 2015, Odunfa ,1981). This study therefore, is designed to extract and characterize oil from African locust bean seed, and to ascertain its appropriate area of application.

The aim of this research work was achieved through the following objectives;

- i. To determine the proximate composition of African locust bean seeds.
- ii. To extract and determine the oil yield from African locust bean seeds.
- iii. To determine the physicochemical properties of oil from African locust bean seed.
- iv. To determine the functional groups present in the extracted oil using Fourier Transform Infrared Spectroscopy (FTIR).
- v. To determine the fatty acids compositions in the extracted oil using Gas Chromatography Mass Spectrophotometry (GC-MS).

2.0 MATERIALS AND METHODS

This focuses on the materials, methods and procedure for this work as presented below.

2.1 Sample Collection and Preparation

Parkia biglobosa seed was collected from Mararraba in Donga local government area in Taraba state. The Sample was screened and cleaned thoroughly to remove the bad ones and ensured they were free from dirt. The seeds were dehulled, washed, and sun dried before grounding. The grounded sample was put in a plastic bottle and stored in freezer for further analysis.

2.2 Procedures for Proximate Analysis

Standard methods of the Association of Official Analytical Chemists (AOAC 2000) was used for determination of moisture, total ash content, crude fibre contents, crude fat and Kjeldahl's method for crude protein analysis.

2.2.1 Determination of Moisture Content

The apparatus used are:

Crucible, Desiccator, Weighing balance and Oven.

Procedure

A clean crucible was dried to a constant weight in an air oven at 105⁰C, cooled in a desiccators and weighed (W_1). 2.0 g of the sample were weighed in the crucible (W_2) and dried in the oven at 105⁰C for 8 h. The crucible and its contents were cooled in desiccators and weighed (W_3). The procedure was continued until a constant weight was obtained.

The moisture content was calculated as:

$$\% \text{ Moisture} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \dots\dots\dots 1$$

Where; W_1 = Weight of empty crucible; W_2 =Weight of crucible + sample before oven drying;
 W_3 = Weight of crucible + sample after oven drying.

2.2.2 Determination of Ash Content

The apparatus used are:

Muffle Furnace, Weighing Balance, and Crucible.

Procedure

2 g of the finely ground sample was weighed (W_2) into a previously weighed clean crucible (W_1) which had been ignited in the muffle furnace at 550°C for 30 min and cooled in a desiccators. The crucible and its contents were transferred into the muffle furnace and the temperature was gradually increased until it reached 550°C , after maintaining the sample at this temperature for some time, the crucible and its residue were allowed to cool down to 20°C . This was removed and cooled in the desiccators and the procedure was continued until constant weight was obtained (W_3).

The ash content was calculated as follows:

$$\% \text{ Ash} = \frac{W_3 - W_1}{W_2 - W_1} \times 100 \dots\dots\dots 2$$

Where; W_1 = Weight of empty crucible; W_2 = Weight of sample in crucible before incineration; W_3 = Weight of sample in the crucible after incineration.

2.2.3 Determination of Crude Fibre

The apparatus used are:

Crucibles, Weighing balance, Desiccators, Oven, Muffle furnace, Round bottom flask, Hot plate, Beakers and measuring cylinders.

Procedure

2.0 g of the sample was put into a round bottom flask, 100 cm^3 of (0.23M) sulfuric acid solution was added and the mixture boiled under reflux for 30 minutes. The hot solution was quickly filtered under suction. The insoluble matter was washed several times with hot water until it was acid free. This was quantitatively transferred into the flask and 100 cm^3 of (0.312M) sodium hydroxide solution was added and the mixture boiled again under reflux for 30 min and quickly

filtered under suction. The insoluble residue was washed with boiling water until it was alkaline free. It was dried to constant weight in the oven set at 100⁰C, cooled in a desiccator and weighed (C₂). The weighed residue was then incinerated in a muffle furnace at 550⁰C for 30 min, cooled in the desiccators and reweighed (C₃).

The percentage crude fiber was calculated as follows:

$$\% \text{ Crude Fibre} = \frac{C_2 - C_3}{W} \times 100 \dots\dots\dots 3$$

Where; W = Weight of original sample; C₂-C₃ = the loss in weight on ashing (incineration).

2.2.4 Determination of Crude Lipid (Fat)

The apparatus used are:

Soxhlet extractor, Filter paper, Weighing balance, Oven, Rotary evaporator, Petroleum ether, Anti-bumping granules.

Procedure

100 cm³ of petroleum ether (40-60⁰C) was transferred into a clean dry 250 cm³ round bottom flask fitted with Soxhlet extraction unit. Some anti-bumping granules were then added. Fat free extraction thimbles were weighed (W₁) and an approximate of 0.5 g of the sample was added and weighed (W₂). The thimble was fixed into the Soxhlet extraction unit with forceps and cold water circulation put on. The heating mantle was switched on and heating rate was adjusted at a temperature between 40-60⁰C until the solvent was refluxing at a steady rate. Extraction was carried out for 8 h and the heating mantle was switched off. The thimble was removed and dried to a constant weight in an oven at 70⁰C and reweighed W₃.

The lipid content was calculated as follows:

$$\% \text{ lipid} = \frac{W_1 - W_3}{W_2 - W_1} \times 100 \dots\dots\dots 4$$

Where, the weight of lipid extracted (crude fat) was given by the loss in weight ($W_2 - W_1$) of the thimble content after extraction.

2.2.5 Determination of Crude Protein

The reagents used are:

Concentrated Sulfuric acid, 40% sodium hydroxide, Catalyst mixture (K_2SO_4 + anhydrous $CuSO_4$), 4% boric acid, Methyl red indicator and 0.1M hydrochloric acid.

Procedure

Exactly 2 g of the sample was weighed into 100 cm³ Kjeldahl digestion flask and about 1g of catalyst mixture ($CuSO_4$ and Na_2SO_4) was added to speed the reaction. 25 mL of concentrated sulfuric acid was added into the flask. The content in Kjeldahl digestion flask was heated slowly at first in the Kjeldahl digestion heating unit until fretting subsides and then more vigorously with occasional rotation of the flask to ensure even digestion and avoid over heating of the content. This continued until a clear solution was obtained. After cooling, the solution was transferred into a 100 cm³ volumetric flask and diluted to mark (100 cm³ mark) with distilled water. 10 mL aliquot of the diluted solution or digest was pipetted into Markham semi micro fixed nitrogen, and 10 cm³ of 40 % sodium hydroxide (40 g of NaOH pallets dissolved in 100 mL of distilled water) was added. The solution was distilled and the liberated ammonia was trapped in a 100 cm³ conical flask containing 10 cm³ of 4% boric acid (4 g of H_3BO_3 powder dissolved in 100 mL of distilled water) and two drops of methyl red indicator. Distillation was continued until the pink colour turned greenish. The content of the conical flask was titrated with 0.1 M HCl (2.2 mL HCl in 250 mL of distilled water) with the end point indicated by a change greenish colour to pink.

% Total Nitrogen was calculated from the formula below:

$$\% \text{ Nitrogen} = \frac{V_1 \times V_0 \times M \times 14 \times 100}{W \times 1000 \times 10} \times 100 \dots\dots\dots 5$$

Where; V_0 = Volume of diluted digest; V_1 = Total volume of HCl used; M = Concentration of HCl (0.1 M); 14= Atomic weight of nitrogen; 100= Total volume of digest; 100= % conversion; 10= Volume of distillate taken; W = Weight of sample taken in grams; 1000= Conversion to dm^3 ; W = Weight of Sample.

The crude protein was calculated as:

$$\% \text{ Crude Protein} = 6.25 \times \% \text{ Nitrogen} \dots\dots\dots 6$$

Where; 6.25= Conversion factor.

The conversion factor was calculated as:

Proteins contain 16 % nitrogen. Therefore $100/16 = 6.25$.

2.2.6 Determination of Total Carbohydrates

Total carbohydrates were calculated by difference rather than direct analysis according to the FAO, (2003) method. All components other than carbohydrate (moisture, ash, crude protein, crude fat and crude fibre) were individually determined, summed and subtracted from 100 (total percentage of powder components) using the following formula:

$$\text{Total carbohydrates} = 100 - (\% \text{moisture} + \% \text{ ash} + \% \text{ protein} + \% \text{ fat} + \% \text{crude fibre}) \dots\dots\dots 7$$

2.3 Extraction of Oil from African Locust Bean Seed

The apparatus used for the extraction are:

Soxhlet extractor, Condenser, Round bottom flask, Heating mantle, Weighing balance, 300 cm^3 n-hexane and Rotary evaporator.

Extraction of oil from African locust bean (*Parkia biglobosa*) seeds was carried out by Soxhlet extraction method. The Soxhlet apparatus consists of a glass extractor, fitted in between a round

bottom flask at the bottom and a condenser at the top. Inside the glass thimble holder, 150 g of African locust bean seed powdered sample was weighed into the porous thimble and placed in a Soxhlet extractor, the round-bottom distillation flask initially contained 300 cm³ of n-hexane (with boiling point of 40-60°C) as extracting solvent. The set-up is heated up by a heating mantle for 6 hours. The oil was removed from the obtained extract under reduced temperature and pressure and refluxed at 70°C to remove the excess solvent from the extracted oil using rotary evaporator. The oil was then stored in a freezer at – 2°C for subsequent physicochemical and other analyses (Abdulhamid *et al.*, 2014).

2.3.1 Determination of Oil Yield (%)

The extracted oil was transferred into a measuring cylinder which was placed over water bath for 30 min at 70°C to ensure complete evaporation of solvent and volume of the oil was recorded and expressed as oil content (%) (Warra *et al.*, 2011).

The oil content was calculated as follows:

$$\text{Oil content} = \frac{\text{weight of the oil}}{\text{weight of the sample}} \times 100 \dots\dots\dots 8$$

2.4 Physicochemical Analysis

Physicochemical analysis of the oils was conducted using the standard methods reported by (Akpan *et al.*, 2006; Association of Official Analytical Chemists, AOAC, 2000). The parameters analyzed were the iodine value, saponification value, acid value, peroxide value, colour, specific gravity and free fatty acid as follows:

2.4.1 Determination of Saponification Value

The reagents used are:

- i. Ethanolic KOH

- ii. 0.5M HCl
- iii. Phenolphthalein

Procedure

Exactly 2 g of the oil sample was added to a flask containing 30mL of ethanolic KOH and then attached to a condenser and heated for 30 min to ensure that the sample was fully dissolved. After sample was cooled, 1 mL of phenolphthalein was added and titrated with 0.5 M HCl until a pink colour appeared, indicating the end point. The procedure was also carried without the sample for the blank (AOAC, 2000).

The expression for saponification value is given by:

$$\text{Saponification Value} = \frac{56.1 \times N(V_0 - V_1)}{W} \dots\dots\dots 9$$

Where; V_0 = the volume of the solution used for blank test; V_1 = the volume of the solution used for determination; N = actual normality of the HCl used; W = Mass of the sample.

2.4.2 Determination of Iodine Value

The reagents used are:

- i. Wijs' Reagent
- ii. Sodium thiosulphate
- iii. 1% Starch Solution
- iv. 10% potassium iodide
- v. Carbon tetrachloride (CCl₄)

Procedure

0.4 g of the sample was weighed into a conical flask and 20 mL of CCl₄ was added to dissolve the oil. Then 25 mL of Wijs' reagent was added to the flask using a safety pipette in fume hood. Stopper was then inserted and the content of the flask was vigorously swirled. The flask was then

placed in the dark for 2 h 30 min. At the end of this period, 20 mL of 10% aqueous potassium iodide and 125 mL of distilled water were added using measuring cylinder. The content was titrated with 0.1M sodium-thiosulphate solutions until the yellow colour almost disappeared. Few drops of 1% starch indicator was added and the titration continued by adding thiosulphate drop wise until blue coloration disappeared after vigorous shaking. The same procedure was used for blank test (AOAC, 2000; Akpan *et al.*, 2006).

The iodine value is given by the expression:

$$\text{Iodine Value} = \frac{12.69 \times C \times (V_1 - V_2)}{W} \dots\dots\dots 10$$

Where; C = Concentration of sodium thiosulphate used; V₁ = Volume of sodium thiosulphate used for blank; V₂ = Volume of sodium thiosulphate used for determination; W = Mass of the sample.

2.4.3 Determination of Acid Value

The reagents used are:

- i. Ethyl alcohol
- ii. phenolphthalein
- iii. 0.1M KOH

Procedure

Two (2 g) of the oil was weighed into a 250 ml conical flask. 50 ml of neutralized ethyl alcohol was added to the oil sample. The mixture was then heated in a water bath. The solution was titrated against 0.1 M KOH using phenolphthalein as indicator (AOAC, 2000).

The acid value was calculated using the expression;

$$\text{Acid Value} = \frac{A \times M \times 56.1}{W} \dots\dots\dots 11$$

Where, A = Amount (mL) of 0.1M KOH consumed by sample, M= Molarity of KOH, W= weight (g) of oil sample

2.4.4 Determination of Peroxide Value

The reagents used are:

- i. Chloroform
- ii. Potassium Iodide
- iii. Acetic Acid
- iv. Sodium thiosulphate

Procedure

Exactly 1.0 g of potassium iodide and 20 mL of solvent mixture (glacial acetic acid: chloroform, 2:1 v/v) were added to 1.0 g of the oil sample and the mixture was boiled for one minute. The hot solution was poured into a flask containing 20 mL of 5% KIO₃ solution. Few drops of starch solution were added to the mixture and was latter titrated with 0.025 M Na₂S₂O₃ solution (AOAC, 2000; Akpan *et al.*, 2006).

The peroxide value was calculated using the expression;

$$\text{Peroxide Value} = \frac{V \times M \times 1000}{W} \dots\dots\dots 12$$

Where; V= Volume of sodium thiosulphate solution used; M= Molarity of thiosulphate; W= Weight of the oil sample.

2.4.5 Determination of Percentage Free Fatty Acid

Using Da-Tech, (2016) method, the percentage free fatty acid of the oil sample was obtained from the acid value of the oil sample as follows:

$$\% \text{ free fatty acids} = \frac{\text{Acid value}}{2} \dots\dots\dots 13$$

2.4.6 Determination Specific Gravity of the Oil

Density bottle was used in determining the specific gravity of the oil. A clean and dry stoppered bottle of 25 mL capacity was weighed (W_0) and then filled with the oil stoppered and reweighed to give (W_1). The oil was substituted with distilled water after washing and drying the bottle and weighed to give (W_2) (Isah, 2006; Atta, 2003).

The specific gravity was calculated as:

$$\text{Specific gravity} = \frac{W_1 - W_2}{W_2 - W_0} \dots\dots\dots 14$$

Where W_0 = weight of dry empty density bottle; W_1 = weight of density bottle + oil; W_2 = weight of density bottle + distilled water.

2.5 Functional Group Test Using FTIR

The functional group of the oil sample was analyzed by using Shimadzu, Fourier transform infrared spectroscopy (FTIR) machine with model number FTIR-8400S. The absorption frequency spectra was recorded and plotted as transmittance versus wave number. The standard IR spectra of hydrocarbons were used to identify the functional groups of the oil.

2.6 Determination of Fatty Acids Composition

Fatty acid composition of the oil sample was determined by GC-MS method as described in AOAC (2002).

2.6.1 Preparation of Methyl Ester of Fatty Acid

1.0 g amount of oil were weighed and transferred to a Teflon test tube. 10 mL of 0.5 M methanolic KOH was then added to the oil sample. The mixture was refluxed until the globules of the oil got into solution in 90 minutes. 2 M sulphuric acid was then added to the cooled mixture to liberate the fatty acids. Esterification of the liberated fatty acids was carried out in the presence of catalytic amount of methanolic BF_3 (10 mL) and boil for 20 minutes. The esterified

mixture was cooled and extracted with hexane. Separate hexane layers were washed with water and dried over anhydrous sodium sulphate (AOAC 2002).

2.6.2 GC-MS Analysis

Fatty acids composition of the methyl ester was determined by GC/MS analysis. A Gas Chromatograph (Make: Agilent 19091S-433UI) with HP column, equipped with thermal auxiliary detector and Helium as carrier gas. The operating conditions were; oven temperature 325⁰C, column temperature 150⁰C, automatic sampler injector, injector volume 1 μ m, injector temperature 200 °C, constant flow, 250⁰C inlet temperature, 10psi pressure and 50-550 scan mass range.

3.0 RESULTS

3.1 Results of Proximate Analysis of African Locust Bean Seed

The proximate analyses of African locust bean seed is presented in Table 3.1.

Table 3.1: Results of Proximate Analysis of African Locust Bean Seed

Proximate parameters (%)	African locust bean seed
Moisture	5.12±0.02
Ash	6.71±0.06
Crude fibre	9.22±0.01
Crude fat	16.14±0.11
Crude protein	9.87±0.08
Carbohydrates	52.94±0.04

3.2 Results of Oil Yield and Physicochemical Parameters African Locust Bean Seed Oil

The percentage oil yield and physicochemical analyses in this study is presented in Table 3.2.

Table 3.2: Results of Oil Yield and Physicochemical Parameters of African Locust Bean Seed Oil.

Parameter	African locust bean seed
Yield (%)	11.41±0.03
Colour	Yellowish Brown
Acid value (mg/g)	8.96±0.05
Iodine value (g/100g)	82.40±0.23
Peroxide value (meqO ₂ /kg)	3.18±0.12
Saponification value (mg KOH/g)	180.11±0.07
Specific gravity	0.9058±0.14
Free fatty acid (%)	4.48±0.09

3.3 Result of FTIR Analysis on African Locust Bean Seed Oil

The FTIR analysis on African locust bean seed oil is presented in Figure 3.1.

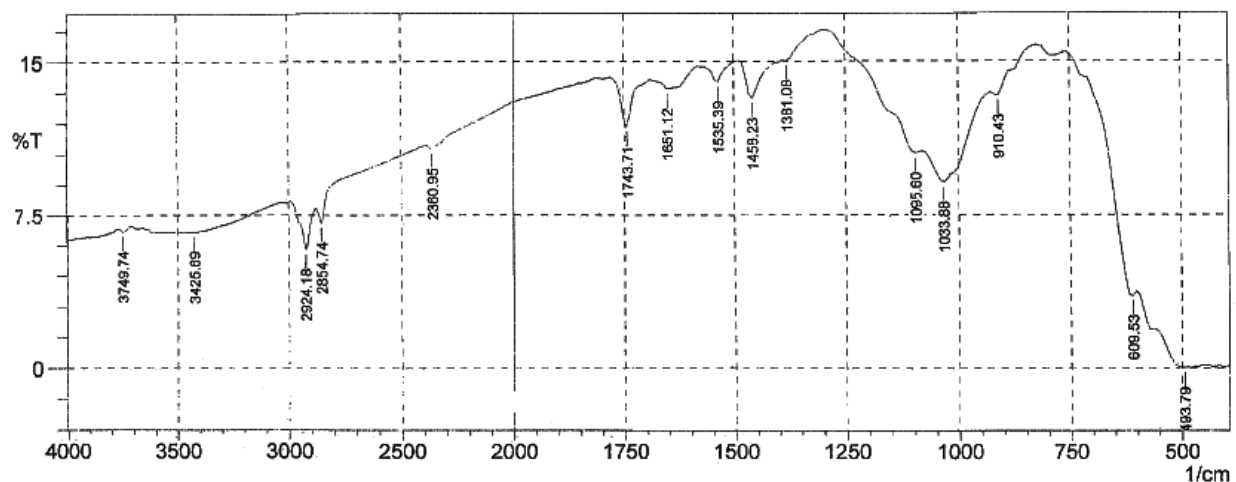


Figure 3.1: Result for FTIR on African locust bean seed Oil.

3.4 Results for GC-MS Analysis on African Locust Bean Oil

The major dominating fatty acids type composition, their corresponding weight compositions and retention time is presented in table 3.3.

Table 3.3: Result for GC-MS Analysis on African locust bean oil

Retention Time	IUPAC Name	Common Name	Saturation	Weight Composition(%)
5.479	Decanoic acid	Capric acid	C10:0	11.30
6.546	Dodecanoic acid	Lauric acid	C12:0	17.5
7.222	Tridecanoic acid	Tridecyclic acid	C13:0	9.7
14.158	Hexadecanoic acid	Palmitic acid	C16:0	7.1
17.323	9,12-octadecanoic acid	Linoleic acid	C18:2	31.9
17.964	Octadecanoic acid	Stearic acid	C18:0	5.2
Others	Minute	Minor		17.26

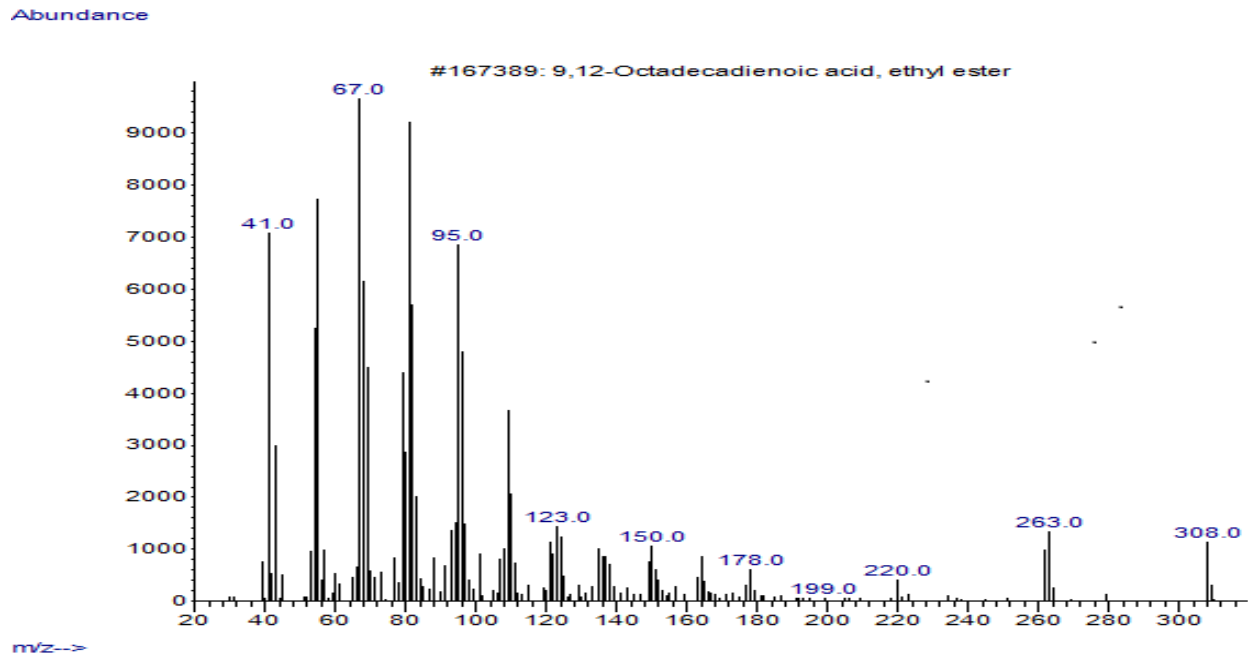


Figure 3.2: Linoleic acid from African locust bean seed oil (GCMS Analysis).

4.0 Discussion of Results

The important nutrients needed to consider when choosing foods for human consumption and animal feeds are crude protein, crude fat, crude fibre, moisture content, ash content and energy. Therefore, Table 3.1 represents the results of proximate composition carried out on African locust bean seed. The result indicates that African locust bean seed in this study was observed to have relatively high moisture content (5.12%). This high moisture content could be attributed to variety in seed or differences in geographical condition such as rainfall in the seeds respective locations (Atta, 2003). This is also an indication that African locust bean contained higher percentage of water which may make the locust bean highly susceptible to microbial attack. The value of 5.12% moisture content obtained for African locust bean was higher than that of cranberry bean, Date palm fruits, baobab and peanut as reported by Aremu *et al.*, 2010, Shaba *et al.*, 2015, and Birnin-yauri and Garba, 2011 respectively. Furthermore, ash content which is an indication for essential valuable and useful minerals needed for good body development was

found to be 6.71% for African locust bean seeds. This is a clear indication that *Pakia biglobosa* contained more amount of inorganic matter. However, it is recommended that ash content in seeds should fall in the range of 1.5-2.5% in order to be suitable for feeds (Aremu *et al.*, 2006). The increase in value of the ash content in African locust bean is similar with the literature study of Omafuvbe *et al.*, (2004) for *Pakia biglobosa* but in contrast to the observation reported for *Luffa cylindrical* (Olaofe *et al.*, 2008) and *Anarcadium occidentale* (Aremu *et al.*, 2006). Crude fibre which plays a significant role in the maintenance of internal distention in intestinal tract as its physiological effect was found to be 9.22% for African locust bean. This value is higher compared to that reported by Shaba *et al.*, (2015). Therefore, it is said that adequate consumption of dietary fibres from a variety of foods protects the body against colon cancer and also help to normalize blood lipids, thereby reducing the risk of cardiovascular diseases (Suzanne, 2003). Thus, it is important to avoid consumption of foods poor in fibres. Similarly, fats are important in diet because they promote fat soluble vitamin absorption and are high energy nutrient. Crude fat value for African locust bean seeds was 16.14%. Lower crude fat value depicts low amount of energy given food (Shaba *et al.*, 2015).

Crude protein is one of the most important nutrients in seeds/foods needed for growth and production of meat. The crude protein value African locust bean seed was 9.87%. It is actually low when compared with study of chemical composition and some functional properties of Date palm seeds (Mohammed *et al.*, 2013), *Pakia biglobosa* (Olujobi, 2012) and some legume such as *Phaseolus coccineus L.* (Aremu *et al.*, 2010).

Carbohydrates are an essential source of energy. Carbohydrate is also nitrogen free extract calculated by difference accounted for 52.94% in African locust bean as depicted in Table 3.1. This value is slightly lower with those obtained for *Phoenix dactylifera L.* (Mohammed *et al.*,

2013). The carbohydrate content suggests that these seeds could be a good supplement to scarce cereal grains as sources of energy and feed formulations. The carbohydrate value for African locust bean compare well with the range values of 54.18 - 39.77 % seeds reported for *Pakia biglobosa* and *Prosopis africana* (Aremu *et al.*, 2015) but higher than those for Cranberry bean (Aremu *et al.*, 2010), *Citrullus vulgaris* and *Pakia biglobosa* (Omafuvbe *et al.*, 2004).

Similarly, worthy of note to consider in the production of oil for both industrial and consumption purpose are the yield and physicochemical features of the raw material. Therefore, the result of oil yield and physicochemical analysis carried out on the African locust bean seeds oil is presented in Table 3.2. The result shows that *Parkia biglobosa* in this study has a relatively mean oil yield of 11.41%, but less than that of castor seed oil which is 33.2% in (Akpan 2006) . This is an indication that (*Parkia biglobosa* oil) if commercially exploited, could serves as one of the major additional sources of oil. However, the values obtained in this study is slightly lower than a similar study by Talabi and Enujuigha, (2014). The difference in yield variation may be attributed to particle size, climatic changes, and variation in plantation or difference in geographical location (Atta, 2003; Ali *et al.*, 2015). It is also interesting to observe that the specific gravity of locust beans see oil is 0.9058, which makes it to be less dense than water. Hence, African locust bean seed oil is pure and can be accepted as raw materials for industry compared to some other oils like that of Date palm seed. (Powe, 1998; Talabi and Enujuigha, 2014).

Acid value which is an index of free fatty acid content and as an indicator for edibility of oil and suitability for industrial used for *Parkia biglobosa* was found to be (8.96 mg/g). The low value of this oil in this study suggests that the oils are suitable for edible purposes and also in accordance with the report for *Citrullus vulgaris* seeds oil (Omafuvbe., *et al* 2004). Moreover, the iodine

value which is useful in predicting the drying property of oils was found to be in 82.40 g/100g in *Parkia biglobosa*. With these values we can conclude that the oil from bean seed is not a drying oil since iodine values are less than 100 (Pearson, 1976). However, the mean iodine value of *Parkia biglobosa* seed oil was relatively high, signifying that it contains C=C double bond (Thomas, 2002). Furthermore, high iodine value is an indication that the oil could be of importance in the production of leather, dressing, candle lubricants and hydraulic brake fluids, as reported by Adelaja (2006), used in the manufacture of cosmetics, oil paints and vanishes and also serve edible purposes and this observation correspond to the report for *Cucumis melo* seeds oil (Ouatarra *et al.*, 2015), Baobab and Vegetable oils (Birnin-yauri and Garba, 2011) but slightly lesser compared to *Sesamum indicum L.* oil (Mohammed and Hamza, 2008), *Citrullus vulgaris* and *Parkia biglo* (Omafuvbe *et al.*, 2004), Castor seeds oil, African oil bean, and Melon seeds oil (Talabi and Enujuigha, 2014).

The saponification value for *Parkia biglobosa* seed oil is 180.11 mgKOH/g. This value suggests that the oil in *Parkia biglobosa* contain low molecular weight fatty acids. Since according to AOAC (1990), saponification values ≥ 180 mg KOH/g possesses low molecular weight fatty acid. Nevertheless, the values obtained is within the range for sesame seeds (Mohammed and Hamza, 2008), date palm seed (Ali *et al.*, 2015), but higher for Castor seeds and Melon seeds oils (Talabi and Enujuigha, 2014). Finally, peroxide value which is the measure of oxidative rancidity of oil was 3.18 meqO₂/kg for African locust bean seeds oil. The peroxide value was low and is a proved that the oils may not be easily susceptible to deterioration, they are said to be fresh oils (Pearson, 1976). Also this value indicates a little poor resistance to peroxidation which is more susceptible to deterioration during storage. It is therefore necessary to develop improved methods of storing this oil. However, the value obtained in this study is similar with the reported

literature for *Cucurbita pepo*, *Sesamum indicum* and *Cucumis melo* seeds oils (Ouatara *et al.*, 2015),

Figure 3.1 presents the FTIR result for African locust beans oil. The essence of FTIR analysis is to know the types and number of functional groups present in the extracted oil indicating its corresponding peaks and absorbance.

African locust bean oil has a maximum transmittance of 16.5%. out of the 15 peaks that were recorded, 4 peaks were observed on the single bond stretch spectrum, 1 peak on the triple bond spectrum, 3 peaks were observed at the double bond spectrum, while 7 peaks were recorded on the fingerprint region skeletal vibration having C-O, C-H and C-C bonds. The peak at 3425.69 cm^{-1} is assigned to O-H stretch group of alcohols. The peaks in the 2924.18-2854.74 cm^{-1} region are represented to the stretching vibration of C-H of alkanes. The peak at 1743.71 cm^{-1} is attributed to the C=O stretching vibration of carboxylic esters. The peak at 1651.12 cm^{-1} is assigned to the C=C stretching of alkenes. The peak at 1535.39 cm^{-1} represents N-O asymmetric stretch of nitro compounds. The peak at 1458.23 cm^{-1} is assigned to C-C stretch aromatic compound. The peaks in the 1095.6-1033.88 cm^{-1} region are represented to the stretching vibration of C-N aliphatic amines. The peak at 910.43 cm^{-1} is also ascribed to the O-H band carboxylic acids, and the peak from at 609.53 cm^{-1} is accredited to the C-X stretch of alkyl halides.

The Gas Chromatography Mass Spectrometry (GC-MS) result as shown in Table 3.3 presents the GC-MS analysis result for African locust bean seed oil. In this case, 6 dominating fatty acid compounds were present in relative abundant composition. Namely: capric acid, lauric acid, Tridecylic acid, palmitic acid, linoleic acid and stearic acid. It is obvious that linoleic acid has the highest composition of 31.9%, and is also observe to be an unsaturated fatty acid compound.

5.0 Conclusion

This study was conducted to investigate the properties of oil extracted from African locust bean seeds. The work revealed that African locust bean seed has relatively high oil yield compared to seeds like date palm. Nutritional compositions and physicochemical characteristics are relatively good and reasonable, with the exception of the carbohydrates and saponification values which seem to be low, when compared to castor and melon seed oil. This oil could serve for consumption and industrial application for the production of cosmetics, paints and lubricants. However, further research should be carried out to determine the concentration levels of minerals and means of storage to prevent peroxidation.

Competing Interest

There is no conflict of interest among the authors as far as this work is concern.

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