IOSR Journal of Applied Chemistry (IOSR-JAC)
e-ISSN: 2278-5736.Volume 11, Issue 7 Ver. I (July. 2018), PP 37-42
www.iosrjournals.org

Assessing The Suitability Of Ricinodendron Heudelotii Seed Oil For Paint Formulation

Fai Fredrick Yirankinyuki[1], Danbature Wilson Lamayi[1], Umar A. Muhammad [2] and Bashir Musa[1].

[1]*Department of Chemistry, Gombe State University Gombe, Nigeria*
[2]*Department of Chemistry, Federal College of Education (T) Gombe*
Correspondence Author: Danbature Wilson Lamayi[1]

Absract: *The oil from the seeds of Ricinodendron heudelotii (Njangsa) was extracted with n-hexane in soxhlet extractor and was analyzed. The percentage oil yield of the seeds was 52%. The oil quality parameters of the seed were; iodine value; 165.8g/100g oil, peroxide value; 7.2meq/kg, density; 0.91g/m^3, acid value; 0.39, saponification value; 189.3mg/g of KOH, pH value; 6.7, moisture content; 6.0, drying time; 48 hours under ambient temperature and 8 hours in an oven. Ultraviolet analysis was carried out at 210nm-665nm and FTIR analysis was carried out at 1050cm^{-1} – 4329.7cm^{-1} for fresh and dried oil and the results showed that the C=C double bonds were converted to peroxy groups. It was concluded that the Ricinodendron heulodelotii seed oil could be a good binder for making (formulation) of oil paints for surface coating.*

Keywords : *FTIR, Oil extraction, Paint, Ricinodendron heudelotii*

Date of Submission: 25-06-2018 Date of acceptance: 10-07-2018

I. Introduction

Njangsa *(Ricinodendron heudelotii)* plant grows widely in Central and West Africa. The term Njangsa refers to an oily seed tree found in tropical West Africa. It is also known as *Manguella* (Angola), *Esseenang* (Cameroon), *Bofeco* (Zaire), *Wama* (Ghana), *Okheun* (Nigeria), *Kishingo* (Uganda), *Akpi* (Cote divoire) (Plenderleith, 1997). Njangsa is also endemic to tropical Africa (Simon and Leaky, 2006). The native geographical location of Njangsa stretches from Senegal in West Africa to Sudan down to the Western Coast of sub-sahara Africa to Angola (Plenderleith,1997). The tree is also found in Madagascar. (Simon and Leaky, 2006). Simon and Leaky (2006) said that Njangsa grows generally in rain forest and also typical in secondary forest. It can also be found in the deciduous forest, forest edges, secondary scrubs and thickets in semi dry savannah. The main commercial production area of Njangsa is the humid forest of Cameroon (Simon and Leaky, 2006)).

The edible parts of the plant are the highly nutritive kernel present in the seed. The dried and ground kernels are used as flavoring agent in some dishes in West and Central Africa. The paste of ground kernels is used to thicken soup and stew. Oil can be obtained from the kernels. The oil has a yellowish color and tastes similar to groundnut oil. Because of its high content of α - tocopherol, the oil is very stable when sealed and becomes rancid only slowly. Oil obtained from dried kernels and ash from burned wood can also be used for soap and varnish production respectively (Southampton Center for Underutilized Crops(SCUC, 2006).

Vegetation Oils are triglycerides extracted from plants and referred to as fixed oil. Such oils have been part of human culture for millennia. (Wikipedia, 2006). Edible vegetable oils are used as fuel and cooking oil. Many oils, edible and otherwise, are burned as fuel, such as in oil lamps and as substitute for petroleum based fuels. Some of the other uses include wood finishing, oil painting and skin care (Wikipedia, 2006).

Vegetable oil can be classified as drying and non-dying oil (Fairman, 1992). A drying oil forms a solid film after a period of exposure to air. The oil hardens through a chemical reaction in which the components cross link by the action of oxygen (not through the evaporation of water or other solvents). Drying oils are a key component of oil paint and some varnishes. Some commonly used drying oils include linseed oil, tung oils, poppy seed oil, perilla oil, and walnut oil. Their use in paint and binders has declined over the past several decades as they have been replaced by alkyds resins and other binders (Ulrich, 2002).

Most drying oils rapidly increase in viscosity after heating in the absence of air. If the oil is subjected to high temperatures for a long time, it will become a rubbery oil insoluble substance (Gursche and Siegfried, 2008). Drying oils consist of glycerol tri-ester of fatty acids. These esters are characterized by high levels of polyunsaturated fatty acids, especially alpha linoleic acid. One common measure of the "siccative" (drying) property of oils is iodine number, which is an indicator of the number of double bonds in the oil. Oils with an

iodine number greater than 130 are considered drying, those with an iodine number of 115-130 are semi-drying, and those with an iodine number less than 115 are non-drying (Wikipedia, 2006a).
The objective of the study is to assess the suitability of *Ricinodendron heudelotii* as a raw material for paint formulation.

II. Materials And Method

2.1 Sampling

The samples were bought from a border market in Taraba State ,North Eastern part of Nigeria, a border to Cameroon.

2.2 Sample Preparation

The samples were ground using corn miller and the ground samples were stored in a covered plastic bucket and kept ready for oil extraction.

2.3 Method of Extraction

The oil was extracted with the aid of soxhlet extractor. Batches of 250g of the sample were weighed and wrapped in filter paper and then inserted into soxhlet extractor. About 300ml of normal hexane was poured into the extractor. The set up was heated at 60^{o}C for 6 hours after which the cake was removed from the extractor dried in an oven and cooled in desiccators and then weighed again to determine the amount of oil extracted (weight lost). The resulting extract containing the oil was heated to recover the solvent from the oil in rotary evaporator.

$$\text{Oil content} = \frac{weight\ of\ oil - \text{weight of cake}}{weight\ of\ sample} \quad \text{.....1}$$

2.4 Determination of the percentage oil content.

A weight 250g of the sample was defatted exhaustively with normal hexane at 60^{o}C in a soxhlet apparatus. The extract was kept for about a day to remove any spill of the solvent and the extract recovered (weight of oil) was expressed as percentage of the weight sample of dry mass.

$$\%\text{Oil yield} = \left(\frac{weight\ of\ oil - \text{weight of cake}}{weight\ of\ sample}\right) \text{x } 100\% \text{ .....2}$$

2.5 Determination of acid value

The method as described by Danbature *et al.*, (2015) was adopted where by 25ml of diethyl ether and 25ml of ethanol were mixed in a 250ml beaker. The resulting mixture was added to 10g of the oil in a 250ml conical flask and few drops of phenolphthalein indicator were added to the mixture.
The mixture was titrated with 0.1M NaOH with consistent shaking until a dark pink colour was observed and the volume V_o was noted.
The free fatty acid and acid value was calculated as follows:

$$\%\text{FFA} = \frac{MxVo}{1000}\frac{x\ molarmass\ \ of\ oleic\ acid x\ 100}{weight\ of\ sample} \text{.....3}$$

Where; V_o = volume of titration (titre value)
M = molar concentration of NaOH
W = weight of the sample
Acid value = 1.99 x FFA

2.6 Determination of iodine value

Wij's method was adopted in determining the iodine value as described by Diamond and Denmark (1973), whereby 0.2g of the oil was weighed and placed in a 250ml conical flask. 10cm^3 of carbon tetrachloride was added to this and to another 250ml conical flask for a blank. 25ml of Wij's reagent was added to each of the two flasks. The mixture was mixed well and left in the dark for 1 hour. The contents of both flasks were titrated with standard 0.1M sodium thiosulphate solution after 15cm^3 of 10% potassium iodides solution and 100cm^3 of distilled water were added. Starch indicator was used towards the end point with continuous shaking during the titration to ensure the iodine in the carbon tetrachloride layer was transferred to the aqueous layer. The weight of iodine absorbed by 100g of fat was estimated as follows:

$$\text{Iodine Value} = \frac{100 x different\ in\ titre value x thiosulphate\ factor}{weight\ of\ fat\ used} \text{ ... ... 4}$$

1cm^3 of 0.1 sodium thiosulphate = 0.0127g of iodine

2.7 Determination of pH value

The method described by Arinola and Eunice (2013) was adopted where by 2g of oil was poured into a clean dry 250ml beaker and 13ml of hot distilled water was added to the sample in the beaker and stirred slowly. It was cooled in a water bath to 25^{o}C. The pH electrode was standardized with buffer solution of known pH. The electrode was then inserted into the sample and the pH read and recorded.

2.8 Determination of peroxide value

The method described by (Nkafamiya *et al.*, 2007) was adopted whereby 5g of oil was placed in 30ml glacial acetic acid/chloroform (3:2 $^{v}/_{v}$) and saturated solution of potassium iodide (0.5ml) was added to liberate iodine by reacting with the peroxide. The resulting solution was titrated against sodium thiosulphate (0.01M) solution using starch indicator until the yellow color just disappeared. The peroxide value was calculated as follows:

$$PV\left(\frac{meq}{kg}\right) = \frac{M(S-B)\text{x}1000}{weight\ of\ sample(g)} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

Where;
B = blank titre value
PV = peroxide value
S = sample titre value
M = molarity of sodium thiosulphate solution (0.01M)

2.9 Determination of specific gravity

A density bottle was used in determining the density of the oil. A clean and dry density bottle of 25ml was weighed and labeled as W_1. The dried density bottle was filled with water to the mark and the new weighed recorded as W_2. The water was substituted with oil and was recorded as W_3. The expression of specific gravity is as follows:

Specific gravity = mass of the substance / Mass of an equal volume of water

$$\text{SG} = \frac{(W3-W1)}{W2-W1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6$$

2.10 Determination of moisture content

Three evaporating dishes were washed and dried in an oven at the temperature of 105^{o}C for one hour and cooled in a desiccator and weighed. A 20g of the oil sample was weighed into each of the three dry evaporating dishes and dried in an oven at 105^{o}C while removing and weighing at interval of two hours until a constant weight was reached. The following expression was used in calculating moisture content:

Moisture content = average loss in weight of oil / Weight of the oil in grams X 100 7

2.11 Determination of saponification value

In determining the saponification value, the Diamond and Denmark (1973) method was adopted. A 2g of the oil was weighed in a 25ml conical flask to which 5ml of alcohol and 20ml of alcoholic KOH solution were added. Also 5ml and 20ml of 0.5M alcoholic KOH solution were added for the blank and both were refluxed for an hour, after cooling, the contents of the flasks were titrated against 0.5MHCl using phenolphthalein as indicator. The difference in titre value between that of the blank and the sample solution is equivalent to the amount of the fatty acid present 0.5M KOH = 28.05g/dm^3. The saponification value was calculated from following expression.

Where, SV = $\frac{(V_O - V_1)\ M\ X\ 56}{\text{Weight of sample (w)}}$ 8

V_o = volume of acid solution used for the blank.
V_1 = volume of acid solution used for the sample
w = mass of the sample
M = Molarity of the HCl

2.12 Determination of drying time

A 5ml of oil was poured into a clean dry 250ml beaker and 5ml of n-hexane was added to the sample. The mixture of oil and n-hexane were shaken until the oil completely dissolved. Ten plates of 10 x 5cm^2 glasses were used for drying the oil. The oil mixture was poured on the glasses and spread with a brush. The excess oil was drained off by tilting the glass on one side and holding in that position for one minute so that a thin film of

oil was left spread on each glass plate. Five plates were dried in an open place i.e. under the ambient temperature of 32^{o}C and 34^{o}C and relative humidity of 48% and 50% respectively (environmental condition). This was observed at an interval of 6 hours until the plates were dried i.e. when they completely loss tackiness. The other set of five plates was dried in an oven at 70^{o}C and was tested for tackiness at the interval of one hour until they were completely dried (i.e. loss tackiness).

2.13 UV Analysis

UV analysis was carried out on both fresh and dried oil, in chemistry laboratory Gombe State University. For the fresh oil the UV analysis was carried out without processing.The dried oil was scraped from the surface of
glass plates into a 50ml beaker and 20ml of n-hexane was added and shaken until the dried plates of oil dissolved. This was then used for UV analysis.

2.14 FTIR Analysis

IR analysis of fresh and dried oil was carried out in NARICT, Zaria. Fresh oil was used directly for the IR analysis, while the dried oil was prepared for analysis just as for UV analysis.

III. Results And Discussions

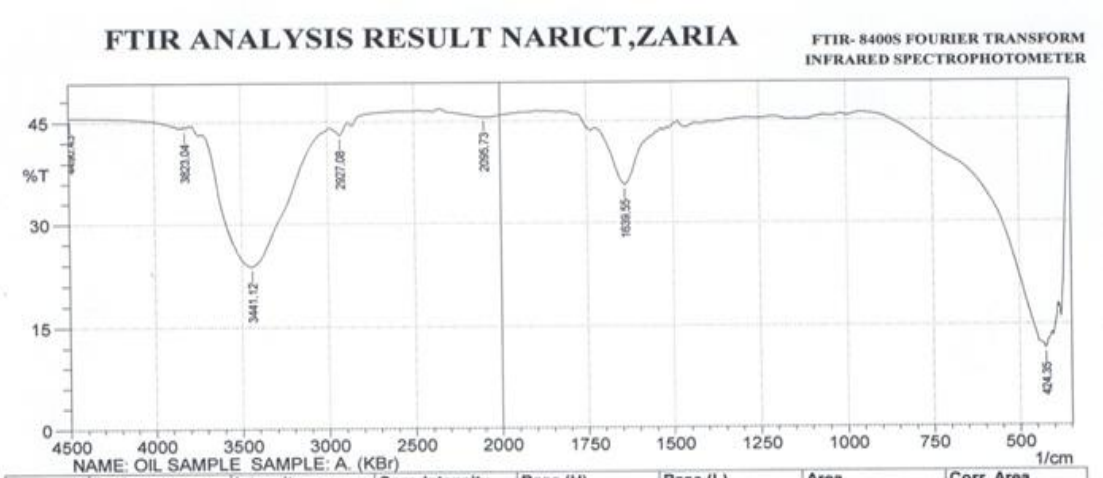
The results for the physico-chemical parameters of the seed oil is shown in Table 1.

Table 1: Physico-chemical parameters of the seed oil.

PARAMETERS	AVERAGE
Colour	Yellow
% oil content	52.2
Volume of oil (ml)	102.7
pH	6.7
Specific gravity (g/m^3)	0.9124
Viscosity	60.32
Acid value (mg/KOH/g)	0.39
Peroxide value (meq/kg)	7.2
Saponification value (mg/KOH/g)	189.3
Iodine value (g/100g)	165.8
Moisture content	6

From Table 1, the percentage oil content average is 52.2%.This implies that the *Ricinodendron heudelotii* seed has a very high oil content and this justifies why the seed looks oily. The specific gravity is 0.91 which is characteristic of vegetable oils. The acid value of 0.39 shows that this oil can be used for food, biodiesel and other uses without treatment (Odhiambo *et al.,* 2005). The iodine value obtained was 165 implying that the oil is a drying oil and can be used in paint formulation. The iodine value obtained is closer to that of the literature (Abayeh *et al.,* 19988). The average peroxide value is lower than those reported in the literature , which is indicative of low level of oxidation of the oils and also suggests the high level of anti-oxidant i.e. the oil is good and would not undergo deterioration easily (Kyari *et al.,* 2008).The average saponification value is 189.3 which shows that the oil can be used for production of soap (Abitogun *et al.,* 2009).The % moisture content is 6 and shows that the oil can be stored for a long period without hydrolysis taking place (Bereziet *et al.,* 2012)

The FTIR spectra of the fresh oil is shown in Figure 1 while that of dried oil is shown in Figure 2.



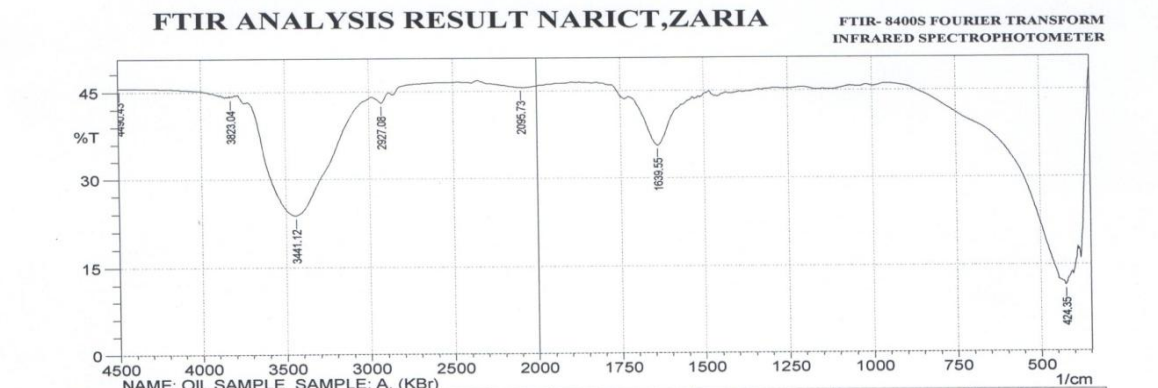
	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	424.35	11.41	1.64	441.71	405.06	33.26	0.88
2	1639.55	35.64	7.51	1712.85	1567.21	58.81	5.67
3	2095.73	45.59	0.02	2351.3	2092.83	87.03	0.33
4	2927.08	43.09	1.4	2984.94	2879.82	37.68	0.67
5	3441.12	23.76	0.22	3445.94	2984.94	218.68	-7.06
6	3823.04	44.15	0.17	3829.79	3813.4	5.81	0.01
7	4490.43	45.6	0	4494.29	4487.54	2.3	0

Comment;
NAME: OIL SAMPLE SAMPLE: A. (KBr)

User; Administrator

No. of Scans;
Date/Time; 7/3/2015 12:31:37 PM
Resolution;

Figure 1: IR spectra for fresh oil.



	Peak	Intensity	Corr. Intensity	Base (H)	Base (L)	Area	Corr. Area
1	424.35	11.41	1.64	441.71	405.06	33.26	0.88
2	1639.55	35.64	7.51	1712.85	1567.21	58.81	5.67
3	2095.73	45.59	0.02	2351.3	2092.83	87.03	0.33
4	2927.08	43.09	1.4	2984.94	2879.82	37.68	0.67
5	3441.12	23.76	0.22	3445.94	2984.94	218.68	-7.06
6	3823.04	44.15	0.17	3829.79	3813.4	5.81	0.01
7	4490.43	45.6	0	4494.29	4487.54	2.3	0

Comment;
NAME: OIL SAMPLE SAMPLE: A. (KBr)

User; Administrator

No. of Scans;
Date/Time; 7/3/2015 12:31:37 PM
Resolution;

Figure 2: FTIR spectra of dried oil

The Fourier Transform Infrared Spectroscopic analysis (FTIR) carried out on fresh oil Figure 1 and dried oil Figure 2, show that the functional groups found in fresh oil and dried oil includes:- OH, C=C, C=O, C-O, NH_2 etc. In Fig 2, that is dried oil, the OH peak is more prominent than the OH in Fig. 1, that is fresh oil due to the loss of C=C as a result of the formation of OH in the dried oil. The absorption band of dried oil is at 3474.88cm^{-1}, while that of fresh oil is 3441.12cm^{-1}. Furthermore, there is presence of C=C at 1600 – 1700cm^{-1} in fresh oil while absent in dried oil C=C is lost, This is because the double bonds have been oxidized to form peroxide linkage and absorption of carbon oxygen double bond C=O in fresh oil is absence while the C=O in dried oil is observed at 1739.9cm^{-1} likewise the carbon oxygen single bond C-O in dried oil is found at 1050-1250cm^{-1} while absence in fresh oil.

The ultraviolet spectral analysis also carried out on fresh oil and dried oil showed the functional group in UV spectra as C=C, C=O, OH, and C – O. There is presence of C = C bond in fresh oil while absent in dried oil. The C = C is found at 133nm, there is also C =O (esters) in fresh oil at 210nm while absence in dried oil, likewise C – O absorption was observed in fresh oil at 180nm which is absent in dried oil. In general only OH functional group is found at 665nm in dried oil while fresh oil does not have OH absorption.

IV. Conclusion

The seed of *Ricinodendron heudelotii* has a high oil content. The oil from *Ricinodendron heudelotii* has a high iodine value and therefore is a drying oil. It could be concluded that *Ricinodendron* seed oil could serve as a binder for paint making and as raw material for the production of resins. It could also be concluded that during drying the carbon-carbon double bond are chemically oxidized to other peroxides bond linkages.

References

[1]. Abayeh, O.J., Aina, E.A. and Okounghae, C.O. (1998). Oil Content and Oil Quality Characteristics of Some Nigerian Oils Seeds. Science Forum: Journal of Pure and Applied Sciences, 1(1):17– 23.

[2]. Abitogun, O; Alademeyin O and Oloye D.A. (2008). Extraction and Characterization of Castor Seed Oil. The Internet Journal of Nutrition and Wellness, 8(2):1-5.

[3]. Akintayo, C.O (2004). Synthesis and Characterization of Albiziabenth Medium oil Modification of Alkyd Resin and its Chemical Modified Derivatives. PhD thesis. University of Ibadan, Ibadan Nigeria. unpublished.

[4]. Arinola Stephen Olanrewasu and Eunice Ogunbusola Moriyike (2013). Effect of Packaging Material o the Storage Stability of Selected Cucurbits Oil. American Journal of Food and Nutrition, 1(3):34-37.

[5]. Berezi, E.P, Soroh, A.and Mark-Manuel D. (2012). Effect of Processing Methods on the Anti-nutritional Factors (ANF) in to Cultivars of Fresh Cocoyam (Colocaesia esculenta and xanthosaniasangittifolium) Leaves. Journal of the Chemical Society of Nigeria, 37:30-32.

[6]. Danbature Wilson Lamayi, Aliyu Jauro and Adamu Harami Malgwi (2015). Production of Methyl Ester from Mahogany (Khaya senegalensis) Sed Oil. Journal of Chemical and Chemical Science, 9: 489-499.

[7]. Diamond, P. S and Denman, R. F. (1973), Laboratory Techniques in Chemistry and Biochemistry: p 152-154.Butterworth and Co (South Africa) Ltd. Durban.

[8]. Fairman, R.M (1992). Minor Oil Crops. Food and Agricultural Organizations. International Technology Development Group; Rugby, UK. ISBN 92-5- 103128-2

[9]. Gursche Siegfried (2008).Coconut oil: Discover the Key to Vibrant Health. Book Publishing Company. P.12. Retrieved 2012-01-21.

[10]. Kyari, M.Z. (2008). Extraction and Characterization of Seed Oil; International Journal of Agro Physics, 22 (3) 139- 142.

[11]. Nkafamiya, I.I., Modibbo, U.U., Manji, A,J and Haggai D (2007). Nutrient Content of Seeds of Some Wild Plants. African Journal of Biotechnology, 6(14)1665-1669.

[12]. Odhiambo P.O, (2005). Tissue Culture Seed Oil Extraction and Characterization of Thevetia peruviana scham (orange and yellow flowering varieties in Kenyaethnobotany).HYPERLINK"http://www.research/kenya.com"www.re search/kenya.com (March 22, 2011.2:30pm).

[13]. Phenderleith, K. (1997). Ricinodendron heudelotii, A State of Knowledge Study Undertaken for the Central Africa Regional Program for the Environment, Oxford, UK: Oxford Forestry Institute Department of Plant Sciences, University Oxford.

[14]. Southampton Centre for Underutilized Crops, SCUC, (2006). Njansa, Ricinodendron heudelottii, Field Manual for Extension Workers and Farmers. pp. 143-156.

[15]. Simons, A.J and Leaky, R.R.R (2006). Tree Domestication in Tropical Agro forestry. Agro Forestry Systems,61:167-181.

[16]. Ulrich Poth (2001). Drying Oils and Related Products,Ullman's Encyclopedia of Industrial Chemistry, Wiley-VCH, Wenham, pp.93-101

[17]. Wikipedia, the Free Encyclopedia (2006).

[18]. https://en.wikipedia.org/wiki/Vegetable_oil

[19]. Wikipedia, the Free Encyclopedia (2006a).

[20]. http://www.wikiwand.com/en/Drying_oil

Fai Fredrick Yirankinyuki "Assessing The Suitability Of Ricinodendron Heudelotii Seed Oil For Paint Formulation." IOSR Journal of Applied Chemistry (IOSR-JAC) 11.7 (2018): 37-42.