



FUTA Journal of Research in Sciences, 2016 (1): 73-80

**EXTRACTION AND CHARACTERIZATION OF VEGETABLE OIL FROM
THEVETIA PERUVIANA AND *JATROPHA CURCAS* SEEDS**

J. M. Jabar^{1*}, L. Lajide¹, I. O. Bakare² and M. T. Oloye¹

¹Chemistry Department, the Federal University of Technology, P.M.B 704 Akure, Ondo State.

²End-Use Division, Rubber Research Institute of Nigeria, P. M. B. 1049, Benin City, Edo State.

imjabar@futa.edu.ng

ABSTRACT

Thevetia peruviana and *Jatropha curcas* oils were cold extracted from their seeds using petroleum ether as extracting solvent. Characterization of the extracted vegetable oils showed that oil yield was greater than 50 % from both seeds. The moisture content of the extracted vegetable oils was less than 0.1 %, while their specific gravities were 0.908 and 0.907 for *T. peruviana* and *J. curcas* oil respectively. The refractive index and viscosity of the oils are 1.440 and 152.9 mPa.s for *T. peruviana* oil, 1.465 and 156.8 mPa.s for *J. curcas* oil respectively. The chemical properties of the oils showed free fatty acid values of the *T. peruviana* and *J. curcas* oil to be within the range of other vegetable oils. The iodine values of the oils confirmed the liquid nature of the oils. The results obtained revealed that the extracted vegetable oils are of good quality for cosmetics, soap, paint, and polyurethane productions, because of their high yield among other properties. The vegetable oils are not good for cooking, because of their inedible nature (free fatty acid is greater than 4 mgKOH/g in *J. curcas* oil and *T. peruviana* oil contains toxic cardiac glycoside).

Key words: Cold extraction, *Jatropha curcas*, Petroleum ether, *Thevetia peruviana*, Quality

INTRODUCTION

Jatropha is the genus name for a number of plants which occur in the family Euphorbeaceae. In

Nigeria, there are several species of *Jatropha* which are commonly grown in gardens as ornamental plants. Many of this plant species produce very colourful flowers, which call the attention of

butterfly and bee. Some of the species commonly found in Nigeria are *J. integerrima*, *J. cardiophylla*, *J. cathartica*, *J. cinerea*, *J. cuneata*, *J. podagrica* and *J. curcas* (Jabar, 2015). Among these species, *J. curcas*, known as 'botuje' in Yoruba (South-west Nigeria) has been identified as having the potential to produce large amounts of oil (Adebayo and Elelu, 2011). It flowers and produces fruits throughout the year with average of 2-4 seeds per fruit depending on the age of the fruit, rain fall pattern and geographical location (Adebayo and Elelu, 2011). It has a life-span of 60 years, while producing seed for up to 50 years with oil content of about 50 % (Sricharoenchaikul *et al.*, 2007).

There are two varieties of the oleander plant; both belong to order *apocynales* of *apocyanaceae* family (Sahoo *et al.*, 2009). One with yellow flowers is called yellow oleander (*Thevetia. peruviana*), and the other with purple flowers is known as nerium oleander (*T. nerrifolia*) (Usman *et al.*, 2009). *T. peruviana* is a native of tropical America; especially Mexico, Brazil and West Indies and has naturalized in tropical regions worldwide. In the native countries, it is believed to be more than 2000 years old and known as yellow oleander, gum bush or milk bush, exile tree, olomi ojo in India, cabalonga in Puerto Rico, ahanai in Guyana, Yoruba in Nigeria respectively (Sahoo *et al.*, 2009). In Nigeria, *T. peruviana* has been grown for over fifty years as an ornamental plant in homes, schools and

churches (Ibiyemi *et al.*, 2002; Usman *et al.*, 2009), flowers and fruits all the year round, providing a steady supply of seeds from fruits of between 400 – 800 per annum depending on the rainfall pattern and plant age (Balusamy and Manrappan, 2007; Usman *et al.*, 2009), each of the fruits contains between one to four seeds of oil content 60 to 65 % in its kernel (Ibiyemi, *et al.*, 2002).

The three common methods by which seed oil is extracted from its oil bearing seeds are; mechanical pressing, supercritical fluid extraction and solvent extraction (Jabar *et al.*, 2015). Despite the fact that there is high level of oil in the seeds of these two plants, their oils remain non-edible because of the presence of hydrogen cyanide and cardiac glycoside (toxins) in *J. curcas* and *T. peruviana* oil respectively (Usman *et al.*, 2009), as a result of this, their oils are not used as food but used in industrial production of insecticides, lubricant, bio-diesel, soap, cosmetics, paints, polyol etc (Kareru *et al.*, 2010). The presence of high content of unsaturated fatty acid in their oils makes the chemical modification of the oils to useful products possible. Other examples of high content unsaturated fatty acid oils that can also be used for industrial production are mahu seed oil, jojoba oil, karanja oil, soybean oil, sunflower oil etc (Meyer *et al.*, 2008). This study was aimed at characterizing extracted *J. curcas* and *T. peruviana* oils from their oil bearing seeds as a way of optimizing their utility.

MATERIALS AND METHODS

Materials

J. curcas and *T. peruviana* seeds were obtained from Akure south local government area of Ondo state, Nigeria. The seed coats were removed from the seeds using a small head hammer. The seeds were then air dried for 15 days, followed by oven drying for 5 days at 40°C for 6 h in each of the oven drying days to obtain moisture free seeds. After oven drying, the seeds were ground with an electric blender (century). The entire chemicals used were of analytical grade.

Oil content

The vegetable oils from ground seed (500 g) of *J. curcas* and *T. peruviana* were extracted using cold extraction method with petroleum ether used to soak the samples for 2 weeks as extracting solvent with liquor ratio 1:5 according to the method described by Jabar *et al.*, (2015). At the end of extracting period, the extracted oil-solvent mixture was collected, filtered, distilled and evaporated to obtain solvent-free oil. The obtained solvent-free oil was weighed to calculate the oil content as shown in Eq. 1.

$$\text{Percentage oil yield} = \frac{(W_1 - W_2) \times 100 \%}{W_1} \dots\dots$$

(1)

Where; W_1 = Weight of ground seed; and

W_2 = Weight of oil extracted seed cake

Moisture content

Moisture content was determined by putting a known weight of the oil in crucible in an oven at 105 °C for 3 h, heating and reweighing at 15 min intervals in an oven until a constant weight obtained. The crucible was then allowed to cool in a desiccator and moisture content determined as in Eq. 2.

$$\text{Moisture content} = \frac{(W_3 - W_4) \times 100 \%}{W_3} \dots\dots (2)$$

Where; W_3 = Weight of crude oil and
 W_4 = Weight of oven dried oil

Fatty acid profile analysis

The fatty acid composition of *T. peruviana* and *J. curcas* oil was determined using gas chromatograph (Hewlett Packard 6890 powered with HP Chemstation Rev. A 09.01 [1206]) with 30 m long HP-INNOWax (cross-linked PEG) type column, while a flame ionization detector was used and Nitrogen was used as the carrier gas. The injection and detection temperatures were 250 °C and 320 °C respectively. The inside diameter of the column was 0.25 mm and film thickness was 0.5 µm.

Other physicochemical properties

Specific gravity, refractive index, acid value, iodine value, saponification value and free fatty acid were determined based on the Association of Official Analytical Chemists (AOAC, 1984). Viscosity of the oils was determined using NDJ – 5S digital viscometer.

RESULTS AND DISCUSSION

The comparison of percentage composition of the fatty acids component of *T. peruviana* and *J. curcas*

J.M. Jabar *et al.*, FUTA J. Res. Sci., Vol 12, No. 1, April (2016) pp 73-80

oil with those of palm oil and soybean oil is presented in Table 1.

Table 1: Comparison of fatty acids composition of *T. peruviana* and *J. curcas* oil with those of palm oil and soybean oil

Fatty acid	Percentage composition (W %)			
	<i>J. curcas</i> oil	<i>T. peruviana</i> oil	*Palm oil	*Soybean oil
Lauric (12/0)	-	-	-	-
Myristic (14/0)	0.28	0.18	-	0.10
Palmitic (C16/0)	14.40	19.10	40.30	11.00
Palmitoleic (C16/1)	0.73	0.01	-	0.10
Margaric (17:0)	0.36	-	-	-
Stearic (C18/0)	6.40	7.32	3.10	4.00
Oleic (C18/1)	44.09	53.41	43.40	23.40
Linoleic (C18/2)	32.46	19.04	13.20	53.20
Linolenic (C18/3)	0.38	0.26	-	7.80
Arachidic (C20/0)	0.22	0.11	-	0.30
Arachidonic (20/4)	-	0.40	-	-
Behenic (C22/0)	0.13	0.07	-	0.10
Erucic (22/1)	0.45	0.10	-	-
Lignoceric (24/0)	0.10	-	-	-
Saturated	21.89	26.78	43.40	15.50
Unsaturated	78.11	73.22	56.60	84.50

Data obtained from * Meyer *et al.*, 2008.

The percentage saturated and unsaturated fatty acids in *T. peruviana* and *J. curcas* oil fall within the range of fatty acids in other vegetable oils according to the findings of Musa and Folorusho, (2012), who observed that saturated content of vegetable oil is between 11.3 % and 49.9 %, while unsaturated

content is between 49.7 % and 87.3 %. Higher percentage of unsaturated fatty acids with respect to its saturated counterpart is an indication of liquid nature of oils (Table 1).

The physical properties of extracted oils are presented in Table 2, where it shows high oil

content of the *T. peruviana* and *J. curcas* seeds. This implies that the seeds can be exploited

J.M. Jabar *et al.*, FUTA J. Res. Sci., Vol 12, No. 1, April (2016) pp 73-80

and Folorusho, (2012), Belewu *et al.*, (2010) who reported oil yield of 52.7 % and 61 % respectively for *Jatropha* seed and Jaura *et al.*, (2001), who reported oil yield of 53.20 % and 43.32 % for *Pentaclethra macrophylla* and *Citrullus lanatus* seeds respectively.

The low moisture contents of *T. peruviana* and *J. curcas* oils obtained through cold extraction method indicated the long time storage ability of the oils because of their low ability to be attacked by microorganisms according to Taiwo *et al.*, (2008); Doijode, (2001); Adewale *et al.*, (2009); Onyeike *et al.*, (2002). Therefore, oil obtained from cold extraction method is better than mechanical press method (Belewu *et al.*, 2010), better than soxhlet extraction method (Musa and Folorusho, 2012) of obtaining oil from their oil bearing seeds (Table 2). *T. peruviana* oil has light golden colour while *J. curcas* has yellow colour and both have sweet odour like most other vegetable oil. These observations are similar to those made by Jauro, *et al.*, (2001), in

economically and compared favourably with the oil yield of other vegetable seeds according to Musa

extraction and characterization of *Pentaclethra macrophylla* seed oil.

The refractive index obtained showed that *T. peruviana* oil is denser than *J. curcas* oil. The specific gravity was found to be within the range of 0.86 – 0.96 g/mL reported for vegetable oils by Jauro *et al.*, (2001), in extraction and characterization of *Pentaclethra macrophylla* seed oil.

The results of the specific gravity obtained agreed with fatty acid profiles of both oils that showed *T. peruviana* oil having lower unsaturated fatty acid than *J. curcas* oil (Table 1), because the higher the unsaturated fatty acid content of the vegetable oil the less dense the oil (Table 2).

The viscosity of the *J. curcas* oil higher than that of *T. peruviana* oil is an indication that it will flow slower under gravity and further proved the result of fatty acids profiles of the oils.

Table 2: Physical properties of *T. peruviana* and *J. curcas* oil

Parameters	<i>T. peruviana</i> oil	<i>J. curcas</i> oil	<i>J. curcas</i> oil*	<i>J. curcas</i> oil**
Oil yield (%)	62.2±0.02	50.5±0.03	52.75	61.00
Oil moisture content (%)	0.091±0.00	0.083±0.00	0.180	0.102
Colour	Light gold	Yellow	Golden Colour	-
Odour	Sweet	Sweet	-	-
Specific density	0.908±0.00	0.907±0.00	0.913	0.900
Viscosity	152.9 mPa.s	156.8 mPa.s	40 cst	-
Refractive index at 29 °C	1.440	1.465	1.466	-

Data obtained from Musa and Folorusho* (2012); Belewu** *et al.*, (2010).

The refractive index obtained for *T. peruviana* oil (1.440) and *J. curcas* oil (1.465) fall within the values reported for other seed oils by Sodeke (2005), in extraction of oil from water melon seed and analysis. The findings of Musa and Folorusho,

(2012) also agreed with this claim. The lower refractive index of *T. peruviana* oil than that of *J. curcas* oil agreed with Uhiara *et al.*, (2011), who observed that for okra seed and palm oil, refractive index decreases linearly as iodine value decreases (Table 3).

Table 3: Chemical properties of *T. peruviana* and *J. curcas* oil

Parameter	<i>T. peruviana</i> oil	<i>J. curcas</i> oil	<i>J. curcas</i> oil*	<i>J. curcas</i> oil**
Acid value (mg KOH/g)	3.88±0.53	12.50±0.13	36.2	23
Free fatty acid (mg KOH/g)	1.94±0.26	6.26±0.07	18.1	11.94
Iodine value (g/100g of oil)	93.50±1.16	102.93±2.44	105	26.09
Saponification value (mg KOH/g)	181.76±1.83	164.79±2.86	190	230.71

Data obtained from Musa and Folorusho* (2012); Belewu** *et al.*, (2010).

The acid value is an indication of free fatty acid content in vegetable oil. It is known to be affected by duration and condition of storage of the oil (Jauro, *et al.*, 2001). It is about 222 % higher in *J. curcas* oil as a result of the presence of HCN (Meyer *et al.*, 2008).

Free fatty acid is an indication of edibility of vegetable oil and its suitability for industrial use (Abayeh, *et al.*, 2011). The free fatty acid value obtained for *T. peruviana* oil is within the range of edible vegetable oil (below 4 mg KOH/g), but the oil remains non-edible because of the presence of cardiac glycoside in it according to Usman *et al.*, (2009). The value obtained for *J. curcas* oil was

above 4 mgKOH/g (maximum limit value for vegetable oil edibility), therefore, it is non-edible according to the findings reported by Adelaja (2006), in evaluation of mineral constituents and physicochemical properties of some oil seeds. These results showed that the extracted oil cannot be used for cooking rather for industrial purpose. Iodine value measures the degree of unsaturation in vegetable oils and can be defined as the weight of iodine absorbed by 100 parts of the sample oil (Eevera *et al.*, 2009). It is also used for categorizing oil into non-drying (30-80 I₂/100 g oil), semi-drying (80 – 120 I₂/100 g oil) or drying (above 120 I₂/100 g oil) (Abayeh, *et al.*, 2011). The iodine values

obtained for *T. peruviana* and *J. curcas* oil indicated that both oils can be classified as semi-drying oil and the value of *J. curcas* oil higher than that of *T. peruviana* oil shows that it contains higher unsaturated fatty acids than *T. peruviana* oil. This observation agreed with fatty acids profiles of the oil in Table 1. Saponification value is a measure of average molecular weight of the triacylglycerols in oil. The smaller the saponification value the larger the average molecular weight of the triacylglycerols present in the oil and vice versa (Eromosele and Catharine, 1993). The values obtained in this research (Table 3) show that the extracted oils can be used as precursor in chemical industry.

CONCLUSION

The vegetable oils obtained through cold extraction method have longest shelf life due to their low moisture content and free fatty acid value, when compared with those obtained through mechanical press and soxhlet extraction method.

Cold extraction of vegetable seed oil from their oil bearing seeds saves the cost of energy used in operation of mechanical press and soxhlet extraction of the seed oil.

REFERENCES

Abayeh, O.J., Ismail, A. and Abayeh, O.M

(2011). Quality characteristics of pumpkin seed oil. Journal of Chemical Society of Nigeria 36(1), 220-223.

Adebayo, G.B. and Elelu, S.A. (2011).

Physico-chemical characterization of adsorbents prepared from different parts of physic nut plant (*Jatropha curcas*), Proceeding of 34th Annual International Conference of Chemical Society of Nigeria, held in September 2011 at University of Ilorin, Ilorin Nigeria, PHY 078-084.

Adelaja, J.O. (2006). Evaluation of mineral constituents and physicochemical properties of some oil seeds. Electronic Journal of Environmental, Agricultural and Food Chemistry 8, 102-110.

Adewale, A., Rachapudi, B.N., Bhamidipati, V.S.K. and Rotimi, A.O. (2009). Oil composition, mineral nutrients and fatty acid distribution in the lipid classes of underutilized oil of *trilepisiummadagascariense* and *antriarisafricana* from Nigeria. Food Research International 43, 665-670.

AOAC (1984). Official methods of analysis, 14th edition., Association of Official Analytical Chemists, Washington DC, USA.

Balusamy, T., and Manrappan, R. (2007). Performance evaluation of direct injection diesel engine with blends of Thevetia peruviana seed oil and diesel. Journal of Scientific and Industrial Research 66, 1035-1040.

Belewu, M.A., Adekola, F.A., Adebayo, G.B., Ameen, O.M., Muhammed, N.O., Olaniyan, A.M., Adekola, O.F. and Musa, A.K. (2010). Physico-chemical characteristics of oil and biodiesel from Nigerian and Indian *Jatropha curcas* seeds. International Journal of Biological and Chemical Sciences 42, 524-529.

Doijode, S.O. (2001). Seed storage of crop, CBS Publishers and Distributors. New Delhi, India, 11-15 pp.

Eevera, T., Rajendran, K. and Saradha, S. (2009). Biodiesel production process optimization and characterization to assess the suitability of the product for varied environmental conditions, Renewable Energy 34, 762-765.

Eromosele, I.C. and Catharine, O.E. (1993).

Studies on chemical composition and physicochemical properties of seeds of some wild plants. *Plant for Human Nutrition* 46, 251-258.

Ibiyemi, S.A., Fadipe, V.O., Akinremi, O.O., and Bako, S.S. (2002). Variation in oil composition of *Thevetia peruviana* Juss 'yellow oleander' fruit seeds. *Journal of Applied Sciences and Environmental Management* 6, 61-66.

Jabar, J.M. (2015). Synthesis and characterization of natural fibre reinforced bio-based polyurethane foam. Ph. D thesis submitted to School of Postgraduate Study, the Federal University of Technology, Akure, Nigeria.

Jabar, J.M., Lajide, L., Adetuyi, A.O., Owolabi, B.J., Bakare, I.O., Abayomi, T.G. and Ogunneye A.L. (2015). Yield, quality, kinetics and thermodynamics studies on extraction of *Thevetia peruviana* oil from its oil bearing seeds. *Journal of Cereals and Oilseeds* 6(5), 24-30.

Jauro, A., Oshieke, K.C. and Adamu, H.M. (2001). Extraction and characterisation of *pentaclethra macrophyllas* seed oil. *Journal of Chemical Society of Nigeria* 36(1), 180-184.

Kareru, P. G., Keriko, J. M., Kenji, G. M. and Gachanja, A. N. (2010). Anti-termite and antimicrobial properties of paint made from *Thevetia peruviana* (Pers.) Schum. oil extract. *African Journal of Pharmacy and Pharmacology* 4(2), 087-089.

Meyer, P.P., Techaphattana, N., Manundawee, S., Sangkeaw, S., Junlakan, W. and Tongurai, C. (2008). Epoxidation of soybean oil and *jatropha* oil, *Thammasat International Journal of Science and Technology* 13, 1-5.

Musa, U. and Folorusho, A. (2012). Characteristics of a Typical Nigerian

Onyeike, E.N., Olungwe, T. and Uwakweu, A.A. (2002). Chemical composition of selected Nigeria oil seeds and phytochemical properties of the oil extracts. *Food Chemistry* 77, 431-437.

Sahoo, N.K., Pradhan, S., Pradhan, R.C., and Naik, S.N. (2009). Physical properties of fruit and kernel of *Thevetia peruviana* J.: a potential biofuel plant. *International Agrophysics* 23, 199-204.

Sodeke, V.A. (2005). Extraction of oil from water melon seed and analysis. *Quarterly Research Services* 25-30.

Sricharoenchaikul, V., Pechyen, C., Ant-ong, D. and Atong, D. (2007). Preparation and characterization of activated carbon from the pyrolysis of physic nut (*jatropha curcas* L.) waste. *Journal of America Chemical Society*.

Taiwo, A.A., Agbotaba, M.O., Oyedepo, J.A., Shobo, O.A., Oluwadare, I. and Olawumi, M.O. (2008). Effects of drying methods on properties of water melon seed oil. *African Journal of Food Agricultural Nutrition and Development* 8(4), 492-501.

Uhiara, N.S., Ayo, J.A., Anayo, G., Ndife, J. and Abbas, U.F. (2011). Extraction of okra seed oil and comparative characterization with palm oil, *Journal of Chemical Society of Nigeria* 36(1), 20-22.

Usman, L.A., Oluwaniyi, O.O., Ibiyemi, S.A., Muhammed, N.O., and Ameen, O.M. (2009). The potential of Oleander (*Thevetia peruviana*) in African agricultural and industrial development: a case study of Nigeria. *Journal of Applied Biosciences* 24, 1477 - 1487.

Jatropha curcas oil Seeds for Biodiesel Production. *Research Journal of Chemical Sciences* 2(10), 7-12.

