Sains Malaysiana 37(4)(2008): 379-382

Physicochemical Properties of Malaysian *Jatropha curcas* Seed Oil

(Pencirian Fizikokimia Minyak Biji *Jatropha curcas* Malaysia)

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ABSTRACT

Jatropha curcas *oil was extracted using n-hexane as solvent in the Soxhlet extraction method. The physicochemical properties of Malaysian* Jatropha curcas *oil were evaluated. The result showed that the Jatropha seeds consist of 60% (dry w/w) crude oil. The physicochemical properties showed that the seed oil contained low moisture level of 0.02 ± 0.01%, acid value (1.50 ± 0.07%), iodine value (91.70 ± 1.44 mg/g), peroxide value (0.66 ± 0.04 miliequivalence/kg) and saponification value of 208.5 ± 0.47 mg/g respectively. Gas chromatography analysis showed that oleic acid (46.00 ± 0.19%) appears as dominant fatty acid in seed oil followed by linoleic acid (31.96 ± 0.19%) and palmitic acid (13.89 ± 0.06%). High performance liquid chromatography (HPLC) results showed that the dominant triacylglycerols present were PLL (20.40%), OOL (17.98%), POO (15.02%), OOO (14.89%) and OLL (14.00%).*

Keywords: Jatropha curcas; *Oleic oil*

ABSTRAK

Minyak Jatropha curcas *diekstrak dengan pelarut heksana dengan menggunakan kaedah pengekstrakan Soxhlet. Pencirian fizikokimia minyak* Jatropha curcas *Malaysia telah dilakukan. Hasil kajian menunjukkan minyak biji Jatropha mempunyai nilai kelembapan sebanyak 0.02 ± 0.01%, nilai keasidan (1.50 ± 0.07%), nilai iodin (91.70 ± 1.44 mg/g), nilai peroksida (0.66 ± 0.04 militara/kg) dan nilai penyabunan sebanyak 208.5 ± 0.47 mg/g. Analisis kromatografi gas menunjukkan asid oleik (46.00 ± 0.19%) merupakan asid lemak dominan diikuti oleh asid linoleik (31.96 ± 0.19%) dan asid palmitik (13.89 ± 0.06%). Keputusan kromatograpi cecair prestasi tinggi (HPLC) menunjukkan triasilgliserol, TAG yang dominan adalah PLL (20.40%), OOL (17.98%), POO (15.02%), OOO (14.89%) dan OLL (14.00%).*

Kata kunci: Jatropha curcas; *Minyak oleik*

INTRODUCTION

Jatropha curcas is a nut belonging to the *Euphorbiaceae* family. It is cultivated in central and south America, south east Asia, India and Africa (Gübitz et al. 1999). In Malaysia, wild *Jatropha curcas* tree is also known as *jarak pagar* particularly in Peninsular Malaysia area. *J. curcas* tree which can easily be propagated by cutting is widely planted as a hedge to protect the field's erosion, as it is not browsed by cattle. *J. curcas* can grow well under such adverse climatic because of its low moisture demands, fertility requirements and tolerance to high temperatures (Kaushik et al. 2007).

All parts of *J.curcas* plant have their own uses. Like many other Jatropha species, *J. curcas* is a succulent tree that sheds its leaves during the dry season. It is well adaptor to arid and semi-arid conditions and often used for erosion control. The leaves are used in traditional medicine against coughs or as antiseptics after birth, and the branches are chewing sticks (Gübitz et al. 1999). The latex produced from the branches is useful for wound healing and others medical uses. Each fruit contains 2-3 oblong black seeds which can produce oil. The seed kernel oil contained 40-60% (w/w) oil (Makkar et al. 1997). The seed oil extracted is found useful in medicinal and veterinary purposes, as insecticide, for soap production and as fuel substitute (Gübitz et al. 1999).

The composition of *J. curcas* oil from Nigeria consists of main fatty acid such as palmitic acid (13%), stearic acid (2.53%), oleic acid (48.8%) and linoleic acid (34.6%) (Martínez-Herrera et al. 2006). *J. curcas* oil contains high percentage of unsaturated fatty acid which is about 78-84%. This made the oils suitable for biodiesel production. However, the chemical compositions of the oil vary according to the climate and locality. To date, Malaysian varieties of *J.curcas* oil have yet to be characterized. In this paper, we report the physicochemical properties of Malaysian wild *J. curcas* seed oil.

MATERIALS AND METHODS

MATERIALS

J. curcas seeds were obtained from northern part of Malaysia, Perlis and Kedah. The ripe seeds were collected and the damaged seeds were discarded. The seeds were cleaned, de-shelled and dried in an oven at 105°C for 30 minutes. The seeds were ground to powder using a grinder prior to oil extraction. All chemicals used in the study were analytical grade and used without further purification.

OIL EXTRACTION

The extraction of *J.curcas* oil was carried out using solvent extraction. The Jatropha seeds powder were extracted using hexane as a solvent for 6 hours.

CHEMICAL ANALYSIS

Total Lipid Content About 100g of dried seed powder was used in oil extraction and for lipid content determination. The result was expressed as the percentage of lipid in the dry weight of seed powders.

Acid Value Acid value of seed oil was determined according to PORIM official test method (1995) p2.5. The percentage of FFA, *% of FFA* was calculated as oleic acid.

Iodine Value Iodine value of Jatropha seed oil was determined according to AOAC Official Method (1997) 993.20.

Saponification Value The saponification value was determined according to PORIM official test method (1995).

Peroxide Value The peroxide value was determined according to PORIM official test method (1995) p2.3.

Fatty Acid Composition The fatty acid composition was determined using the gas chromatography (GC), 17A Shidmadzu, Japan. About 0.1 mL oil was converted to methyl ester using 1 mL NaOMe (1M) in 1 mL hexane before injection into the GC. The GC was equipped with BPX 70 capillary column (30m × 0.25mm × 0.25μm) and a flame ionization detector (FID). The detector temperature was programmed at 245°C. The column temperature gradient ranged from 120 to 245°C at a flow rate of 0.3 ml/min and nitrogen was used as a carrier gas. The identification of the peaks was archived by retention times by means of comparing them with authentic standards analyzed under the same conditions.

TAG composition TAG profile of *J. curcas* oil was determined by using high-performance liquid chromatography (HPLC) from Waters Model 2410 equipped with refractive index detector. The TAG of the oil was separated using commercially packed C18 column, 4.6 μm × 150.00 mm from Waters. The mobile phase used was a mixture of acetone:acetonitrile (63.5:36.5) set at a flow rate of 1 mL/min. Sample preparation involved sample dilution with acetone:acetonitrile (63.5:36.5) mixture before 20 μL of the sample were injected into HPLC with a total running time of 30 minutes. TAG peaks were identified based on the retention time of available commercial TAG standards. HPLC chromatograph obtained from soybean oil was used as comparison guide in identifying the TAG peaks in *J. curcas* oil. The relative percentages of TAG peaks were evaluated from all peaks where appeared after 8 minutes, the time when the first TAG peak appeared.

PHYSICAL ANALYSIS

Viscosity Viscosity of seed oil was carried out using Brookfield DV-I with spindle number SO5 and stirred at 100 rpm at room temperature.

Refractive Index Refractive index of seed oil was determined using refractometer (Atago Co. Ltd. Series No. 11506, Japan)

RESULT AND DISCUSSION

PHYSICOCHEMICAL CHARACTERIZATION

Table 1 shows the physicochemical properties of the Malaysian *J. curcas* seed oil compared to the Nigerian *J. curcas* seed oil. *J. curcas* seed oil in this study contained relatively high percentage of total lipid content (60.45 ± 4.44%) compared to the Nigerian *J. curcas* seed oil which was 47.25 ± 1.34%. The values are comparable with other seed oil such as *Parkia biloglobbossa* seed oil (26.52 ± 1.02%) and castor oil (46-55%) (Akintayo 2004; Ogunniyi 2006). The iodine value of the Malaysian *J. curcas* seed oil was 91.70 ± 1.44 (mg/g) which is lower than the Nigerian *J. curcas* seed oil. The oil shows a high iodine value due to its high content of unsaturated fatty acids (Table 2). As a crude oil, the peroxide value of Malaysian *J. curcas* seed

TABLE 1. Physicochemical characteristic of Malaysian *J. curcas* seed oil and Nigeria *J. curcas* L seed oil

Parameter	*Value*	
	Malaysia	Nigeria[a]
Iodine Value (mg/g)	135.85 ± 1.44	105.20 ± 0.70
Peroxide Value	0.66 ± 0.04	-
Acid Value (mg KOH/g)	1.50 ± 0.07	3.50 ± 0.10
Free Fatty Acid as Oleic Acid (%)	1.03 ±0.10	1.76 ± 0.10
Saponification Value (mg/g)	208.50 ± 0.47	198.85 ± 1.40
Moisture – Oil (%)	0.02 ± 0.01	-
Viscosity	36.00	17-52
Refractive index at 28°C	1.469	1.468
Color	Golden-yellow	Light yellow
Total lipid content (%)	60.45±1.44	47.25±1.34

Source: [a]Akintayo 2004

TABLE 2. Fatty Acids Composition of Malaysian and Nigerian *Jatropha curcas* Oil

Fatty Acid, %	*Jatropha curcas* L Malaysia	Nigeria[a]
Palmitic	13.89 ± 0.06	19.50 ± 0.80
Palmitoleic	0.61 0.33	-
Stearic	7.16 0.36	6.80 0.60
Oleic	46.40 0.19	41.30 1.50
Linoleic	31.96 0.20	31.40 1.20
∑Saturated Fatty Acid	21.05	26.30
∑Unsaturated Fatty Acid	78.95	72.70

[a] Akintayo 2004

oil showed a low value of 0.66 ± 0.04 miliequivalence/kg. The high iodine value and oxidative stability showed that the seed oil upholds the good qualities of plant oil and semi-drying oil purposes (Eromosele et al. 1997). The acid value and free fatty acid content of the Jatropha oil are low in general. The saponification value of Malaysian *J. curcas* seed oil (208.50 ± 0.47 mg/g) was higher compared to the Nigerian *J. curcas* seed oil (Table 1).

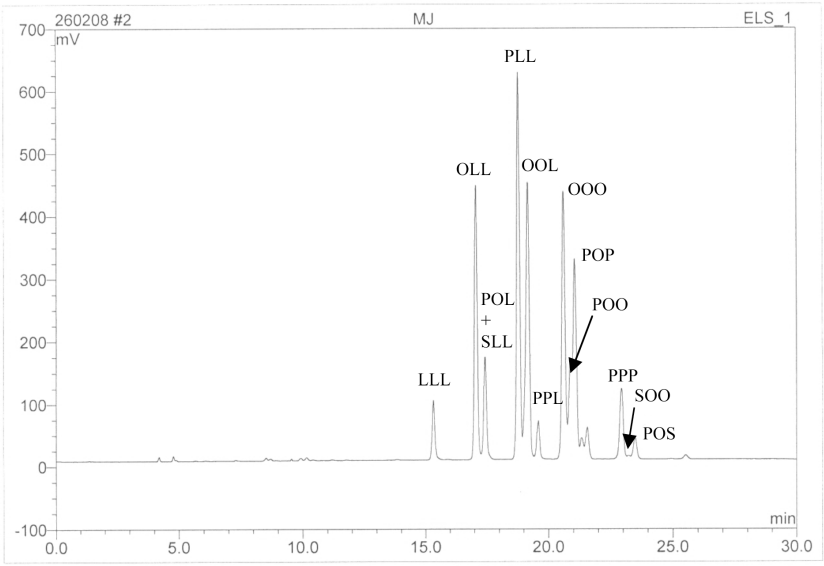
The Malaysian *J. curcas* oil was golden-yellow in color at room temperature, whereas the Nigerian *J. curcas* seed oil was light yellow. The viscosity and refractive index of Malaysian *J. curcas* seed oil were 36cP and 1.469. These are comparable values with others reported elsewhere (Akintayo 2004).

FATTY ACID COMPOSITION

Table 2 shows fatty acid composition of *J. curcas* oil. Three major long chain fatty acids were detected in the Malaysian *J. curcas* oil which are oleic (46.00%), linoleic (31.96%) and palmitic (13.89%) acids. Other fatty acids composition was less than 10% comprised of stearic and palmitoleic acids. In general, the Malaysian *J. curcas* oil contained more unsaturated fatty acids (78.94%) compared to saturated fatty acids (21.05%). Medium Fatty acids such as capric, lauric and myristic were not detected. As a comparison, Malaysian *J.curcas* oil contained less palmitic and more oleic acids compared to the Nigerian *J. curcas* oil which contained 19.50% palmitic and 41.30% oleic acids, respectively (Table 2). The differences in fatty acids composition was expected due to differences in soil and climate condition. However, there is no significant difference in total percentage for unsaturated and saturated fatty acid composition of *J. curcas* oil from both the Malaysia and Nigerian countries. Due to the high content of unsaturated fatty acid composition in the Malaysian *J. curcas* oil indicated by high percentages of oleic and linoleic acids, the oil may be classified as oleic oil and used for a semi drying oil (Augustus et al. 2002). It is plausible that the Malaysian *J. curcas* oil is suitable and potentially useful for surface coating materials and low pour point biodiesel.

TAG PROFILE

Due to its industrial potential, it is crucial to determine the triacylglycerol (TAG) profile for the Malaysian *J. curcas* seed oil. Results from reversed phase HPLC showed that the oil composed of at less thirteen important TAGs (Figure 1). The TAGs composition in *J.curcas* oil was identified according to the equivalent carbon number (ECN). Table 3 shows the TAGs composition detected in Malaysian *J. curcas* seed oil. Major TAGs present were PLL with 20.40% followed by OOO (14.89%) and OOL (17.98%) and OLL (14.00%). Other TAGs present as minor TAG with less than 10% composition. It is expected that crude *J. curcas* oil showed a notable content of monoacylglycerols (MAG) and



Time (minute)

FIGURE 1. HPLC chromatogram of Malaysian *Jatropha curcas* oil

TABLE 3. TAG Composition of Malaysian *Jatropha curcas* oil

TAGs	ECN	Composition (%)
LLL	42	3.00
OLL	44	14.00
POL+SLL	44	5.46
PLL	44	20.40
OOL	46	17.98
PPL	46	1.62
OOO	48	14.89
POO	48	15.02
POP	48	0.82
Unknown	48	0.42
Unknown	48	0.77
PP	48	4.22
SOO	50	0.42
POS	50	1.07

diacylglycerols (DAG) where the peaks were observed before the first TAG peaks appeared at 8 minutes.

CONCLUSION

The study shows that fatty acids composition of the Malaysian *J. curcas* oil is rich in oleic and linoleic acids and the oil can be classified as unsaturated oil. Hence the Malaysian *J. curcas* oil has a great potential for oleochemical application such as surface coating and low pour point biodiesel. Therefore, it is convivial to have more research on *J. curcas* seed oil in the future to explore its potentials for future industrial oilseeds crop.

ACKNOWLEDGEMENT

We would like to thank Universiti Kebangsaan Malaysia and the Ministry of Science, Technology and innovation (MOSTI) for project funding under Research University Grant UKM-OUP-BTT-28/2007 and Science Fund research grant 05-01-02-SF0186, respectively.

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Received : 18 February 2008
Accepted : 18 March 2008