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Comparative Studies on Physicochemical Properties and fatty Acids Composition of Seed Oil of Jatropha curcas and Jatropha glauca

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***Abstract*— (The aim of this study was to investigate the physical and chemical properties of the seeds oil of Jatropha curcas (L) and Jatropha glauca collected from two different regions of Sudan. The physicochemical analyses were carried out using standard analytical methods. Results showed that the specific gravity and refractive index @ 250C were 0.943 and 1.473 for J.curcas compared to 0.951 and 1.470 for J.glauca, respectively. The recorded acid values, saponification number, peroxide values and % of free fatty acids (mgKOHg-1 oil) were, in order, 9.537 and 14.025; 193.40 and 206.70; 1.93 and 2.3; 4.769 and 7.012 for J.curcas and J.glauca, respectively. On the other hand, iodine values (g100g-1oil) were 114.64 and 117.08 for J.curcas and J.glauca, respectively. Fatty acids composition of the two species was revealed using the gas chromatography-mass spectrometry (GC-MS) technique. The dominant unsaturated fatty acids of Jatropha curcas seeds oil were oleic acid (37.03%) and linoleic acid (21.60%), while the saturated fatty acids were stearic acid (10.95%), palmatic acid (17.81%) and archidic (1.00%). Comparatively, the unsaturated fatty acids of J. glauca were linoleic acid (51.74%) and oleic acid (15.37%) whereas the saturated fatty acids of this species were stearic acid (13.18%), palmatic acid (14.92%) and archidic(1.14%). The results of chemical and physical properties of seed oil of the two jatropha species suggest that the seed oil may be suitable for industrial purposes such as production of soaps, paints and lubricants. At the same time, results obtained from (GC) analysis revealed that the types of fatty acids of J. curcas seed oil may be more suitable for production of biodiesel than that of other species.**

***Index Terms*— Jatropha curcas, Jatropha glauca, Physicochemical Properties, Seed Oil , Fatty Acids.**

I. Introduction

The genus Jatropha has 175 known species of the plant belonging to the family Euphorbiaceae. These species are mainly grown in warm temperate regions and seasonally dry tropics. Africa counts 70 native species and Madagascar has 1 endemic. Several other Jatropha species occur in the same region as Jatropha glauca and have medicinal uses [1].[2]mentioned that there are a number of non edible, tree based oil seeds available in many countries around the world from which biodiesel can be produced.

Jatropha curcas L. and Jatropha glauca are multipurpose shrubs with a variety of applications and enormous economic potentials for their seed oil, which can be converted into biodiesel an alternative to petro-diesel. As the future lack of petroleum is a current concern, bio-diesel seems to be "part of the solution", by replacing partial or totally petro-diesel fuel in diesel engines. This reason, added to an increasing environmental concern, creates a scenario in which biodiesel production is expected to have a big development over the next few years [3].

Jatropha glauca occurs in Sudan, Eritrea, Ethiopia, Djibouti and Somalia, and extends to Yemen and Saudi Arabia. Botanically it is describe as small monoecious shrub up to 1 m tall with smooth, pale branches; stems and leaves glabrous to shortly hairy .Jatropha glauca occurs in open bush land, extending to semi-desert conditions, on lava and limestone, from sea-level up to 1000 m altitude. Jatropha glauca is conceder as natural vegetation, dominant plant to western plain of the Red Sea

Hills. Sandy soil is the dominant soil type in the coastal and western plains. Sandy soils are characterized by their low fertility and high infiltration rate, hence unsuitable for cultivation. Natural vegetation is sparse and the grazing capacity is relatively low [4].The region experiences both winter and summer rains. It is estimated that 98% of the region receive less than 200 mm. of annual rainfall. An average annual temperature of western and southern plain is above 22°C [5].Jatropha glauca is relatively common in its distribution area and is not browsed by livestock, it is therefore not likely to be threatened by genetic erosion [6].

The centre of origin of J. curcas is still debatable, but it is believed to be native of Mexico and Central American region. It has been introduced to Africa and Asia in the new world. It is cultivated in many parts of the tropics and subtropics as a hedge crop and for traditional use [7]; [8]. Jatropha occurs mainly at lower altitudes (0-500 m) in areas with average annual temperatures well above 20°C but can grow at higher altitudes and tolerates slight frost. It grows on well-drained soils with good aeration and is well adapted to marginal soils with low nutrient content. The current distribution shows that introduction has been most successful in the drier regions of the tropics and can grow under a wide range of rainfall regimes [9].

The literature indicates that the fatty acid methyl ester of Jatropha curcas is one of the 26 fatty acid methyl esters of oil that are most suitable for biodiesel product [10].

[11] Revealed that the fatty acid composition of J. curcas oil was analyzed by gas chromatography, major long chain fatty acids present in the J. curcas oil which are palmatic acid (16.69%), stearic acid (7.67%), oleic acid (40.39%) linoleic acid (33.09%) and Linolenic acid (0.28%). J.curcas oil contains high percentage of unsaturated fatty acid, which is about 75.64%. Also [12] revealed that Jatropha curcas (L) oil is rich in unsaturated fatty acids especially oleic acid (52.27%) and linoleic acid (27.87%). The dominant saturated fatty acids were palmatic acid (14.24%) and stearic acid (5.15%).These results suggest that Jatropha curcas (L) seed oil may not be suitable for human consumption except it is subjected to detoxification and purification before use, but may be suitable for industrial purposes such as production of soaps, paints and lubricants.The physiochemical properties, energy value, fatty acid composition and oil content of the seeds of Jatropha curcas were investigated by[13];[14];[15]. These physical and chemical properties of Jatropha curcas oil are strongly influenced by the processing, season, climate and geography during the growth of the seed, storage etc. The rainfall, soil type, nutrition content of the soil ,temperature and other factors vary from region to region and hence the physical and chemical properties of the Jatropha curcas oil produced are region specific[16]. Research of seed oil of Jatropha curcas and Jatropha glauca is not available in Sudan. Therefore, it is of great interest to evaluate the physical and chemical properties of the seed oil of these promising plants.

MATERIALAND METHODS

A. 2.1 Plant materials:

Healthy seeds of Jatropha curcas were collected from Jatropha curcas plants cultivated in Alrwakeep research station, National Center for Research, Khartoum, Sudan, whereas the healthy seeds of Jatroph agulaca were collected from Jatroph agulaca plant grown naturally in Sinkat (valleys), Red Sea State, Sudan. The seeds for both species were identified at the Department of Biology & Biotechnology, Faculty of Science &Technology, AlNeedain University.

B. 2.2 Soxhlet extraction:

The method described by [17] with slight modification was a used. The clean dry seeds (25 g) of Jatropha curcas and Jatropha gulaca were grounded using mortar and pestle then defatted in a soxhlet apparatus. The extraction carried out by using petroleum ether (60-80ºC). The process continued for 3 h. Solvent removed by vacuum evaporation in room temperature. Each extraction was run in triplicate and yield % was determined.

C. 2.3 Gas Chromatography-Mass Spectrometry (GC-MS) condition for analysis of fatty acid:

Methyl esters were prepared from total lipids by the method of [18]. These fatty acids methyl esters were analyzed by gas chromatography, Shimadzu series (GC.MS.QP.2010), equipped with mass spectrometer detector and Rtx.50 column having internal diameter 0.25mm and length 30cm. Fatty acids profile obtained through this gas chromatography with relevant standards.

D. 2.4Physicochemicalanalysis:

The specific gravity of the J. curcas and J. glauca oil were determined with specific gravity bottle method as described by [19]. The refractive indices of the oils were read at 250C using an Abbe Refractometer [20].

Iodine value determined by Hanus iodine method [21], while saponification values, acid values, and peroxide values were determined according to [18].The amount of free fatty acid (FFA) was calculated as being equivalent to half the value of acid value. All the analyses were done in triplicate and reagents used were of analytical.

RESULTS AND DISCUSSION:

Data in Table 1 represented the physicochemical properties of J. curcas and J.glauca seed oil. The oil extracted from the two species of jatropha using petroleum ether was transparent liquid at room temperature. The oil extracted from J. curcas seeds has bitter taste which may be due to the present of alkaloid; it has agreeable odour and light yellowish colour. The extracted oil of J. glauca has also bitter taste, pleasant odour and it was golden yellow in colour. The percentage oil yield of J. curcas and J .glauca were 28 and 26%, respectively. These results are contrary to that reported by[22], where the seed oil yield of J. curcas oil was 52.75%.Specific gravity J. curcas seed oil at 250C was 0.94 while it was 0.95 for J. glauca; these values showed consistency with studies of[23]and [22].The refractive indices at 250Cwere1.473 and 1.470 for J. curcas and J.glauca, respectively. These values were in agreement with that reported by [24]. The physical properties of the oil extracted from the two species were approximately similar (Table1).On the other hand the chemical properties of the oil of two species were different as shown in the table 1. An acid value of the seed oil of J. curcas was 9.53mgKOHg-1 oil,this value showed inconsistency with that obtained by [22] and [24], where their findings range between 36.20-36.46 mg KOH/g.This may be due to the difference in the climatic conditions [25].The acid value of J.glauca oil showed higher value than that of J. curcas(14.02 mgKOHg-1 oil).The free fatty acids (FFAs) of J. curcas oil were4.77 mg KOHg-1 oil. This result is quite consistent with the values obtained by previous researchers [12].On the other hand, the FFAs of J.glauca oil were7.01 mg KOHg-1 oil. High FFAs (%wt) cause soap formation during alcoholysis process and lead to difficulties in separation of biodiesel from its byproducts; as a result it reduced the biodiesel yield [26]. Peroxide value were 1.93and2.30 mgKOHg-1 oil and iodine value were 114.64and 117.08 g100g-1oil for J.curcas and J.glauca oil, respectively (Table1). Our results agree with that obtained by [12].A low peroxide value, as seen in the present study, increases the suitability of the oil for a long-time storage due to a low level of oxidative and lipolytic activities. Iodine value is the measure of degree of unsaturation of the oil. Higher iodine value indicates higher unsaturation of fats and oils [27].Saponification number of J. curcas oil recorded in this research was 193.40 mg KOHg-1 oil. This high value was consistent with the findings in the previous literatures [17];[22], who reported that Jatropha curcas oil is usually associated with high saponification value. Such high value establishes the fact that Jatropha curcas oil contains normal triglycerides. In this study, J.glauca seed oil gave higher amount of saponification number (206.7 mg KOHg-1 oil) than that of Jatropha curcas seed oil.

To the best of our knowledge, there is no documented study on seed oil extracted from J.glauca .Figures(1 and 2) as well as Table 2 represent the composition of fatty acids of seed oil of J.curcas and J.glauca ,respectively, as determined by the gas chromatography-mass spectrometry. The properties of the triglyceride and the biodiesel fuel are determined by the amount of each fatty acid that is present in the molecule. Chain length and the number of double bonds determine the physical characteristics of both fatty acids and triglyceride [17]. There are three main types of fatty acids present in a triglyceride: Saturated

(CN:0),monounsaturated (CN:1) and polyunsaturated (CN:2,3) and an ideal vegetable oil as a potential feedstock for biodiesel production should have low saturated and polyunsaturated fatty acid and be high in monounsaturated fatty acid [28]. The results of this study revealed that the Jatropha curcas consist of saturated fatty acid especially palmitic acid(17.81%), stearic acid (10.95%) and archidic acid(1.00%) whereas monounsaturated fatty acid was oleic acid (37.03%)and polyunsaturated fatty acid was linoleic acid (21.60%). This finding of monounsaturated fatty acid of seed oil Jatropha curcas was in accordance with the finding of [22] and approximately agree with that obtained by [11],but the amount of saturated fatty acid and polyunsaturated fatty acid were lower than that obtained by these researches. According to [28] the Jatropha curcas cultivated in Sudan, Khartoum, may be more suitable for biodiesel production. The prevalence of the unsaturated fatty acids and high values of the iodine index indicate that the J. curcas oil is of the unsaturated type [27].

The saturated fatty acids of Jatropha glauca were palmitic acid (14.92 %), stearic acid (13.18%) and archidic acid (1.14%).The results of saturated fatty acids recorded in the present study for J. glauca were approximately within the range of that of Jatropha curcas. Monounsaturated fatty acid of J. glauca was oleic acid (15.37%) and polyunsaturated was linoleic acid (51.74%). J. glauca oil contains high percentage of polyunsaturated fatty acid. Oil containing high amount of polyunsaturated fatty acids tend to exhibit poor oxidation stability, and may not be useful at low temperatures due to a high pour points, but can find an application in the surface coating industries [29]; [30]; and[24].

CONCLUSION:

J. curcas seed oil contained high percentage of monounsaturated fatty acid which is about 37.03%. On the other hand J.glauca showed high percentage of polyunsaturated fatty acid (51.74%). The results of this investigation suggest that J. curcas and J.glauca seed oil have great potentials for future industrial oil seeds crops.

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1. **Table 1:** Physical and chemical properties of seed oil of *J.curcas and J.glauca*

Physicochemical properties		**J.glauca**	**J.curcas**
Physical properties			
Organoleptic	Yield	26%	28.8%
	Taste	Bitter	Bitter
	Odour	Pleasant	Agreeable
	Colour	Golden yellow	Light yellowish
Appearance at room temperature		transparent liquid	transparent liquid
Specific gravity at 250C		0.951	0.943
Refractive index at 250C		1.470	1.473
Chemical properties			
Acid value		14.025	9.537
Iodine value		117.08	114.64
Saponification value		206.7	193.5
% FFA		7.0125	4.769
Peroxide value		2.3	1.93

Table 2: Fatty acids composition of seed oil of J.curcas and J. glauca

No.	Name of The Compound	Composition (%)	
		J.curcas	*J. glauca*
1	Palmitic acid	17.81	14.92
2	Stearic acid	10.95	13.18
3	Archidic acid	1.00	1.14
4	Oleic acid	37.03	15.37
5	Linoleic acid	21.60	51.74