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Chemical Composition, Bio-Diesel Potential and Uses of Jatropha curcas L. (Euphorbiaceae)

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Abstract
This review paper focuses some basic aspect of the taxonomic, biology, cultivation, chemical composition, bio-diesel potential, medicinal values and uses of Jatropha curcas Linn. The genus Jatropha is distributed throughout the tropics and sub-tropics growning in marginal lands and is a potential biodiesel crop worldwide. It grows almost anywhere, even on gravelly, sandy and saline soils. It can thrive on the poorest stony soil. It can grow even in the crevices of rocks. The plants can prevent soil erosion, grown as a live fence and used as an alternate commercial crop. Due to its adaptability to marginal soils and environments, the cultivation of Jatropha curcas is frequently mentioned as the best option for producing biodiesel. The seed oil can be used as a feed stock for biodiesel. Alternatively Jatropha oil is used in soap, glue or dye industry. The seed cake is rich in nitrogen and phosphorus, and can be used as manure. The seed kernel contains predominantly crude fat oil and protein while the seed coat (husk) contains mainly fibre. The seed contains about 42% seed husks (seed coat) and 58% kernels, part of the seed in the seed coat. The matured seeds contain 21% saturated fatty acids and 79% unsaturated fatty acids and they yield 25%–40% oil by weight. All parts of the plant including seeds have medicinal properties. Now days, various countries around the world have proposed vegetable oils and their conversion to biodiesel as a renewable alternative to fossil fuels in which Jatropha curcas L. is one of it. Ash from the roots and branches of Jatropha curcas L. is used as cooking salt, and as lye in dyeing. The dark blue dye extracted from the bark of Jatropha is a useful dye. The plant parts and its oil along with its latex used for different reasons such as pesticides, anti-inflammatory activities, wound healing, lighting (lamp), bio-gas production, fertilizer and other purposes.
Keywords: Chemical composition, *Jatropha curcas*, biodiesel, uses

1. Introduction

Jatropha curcas Linn is commonly known as 'physic nut' is a non-food bioenergy plant and c*urrently* considered as alternative substitute to fossil fuels (Nahar, 2011). It is perennial shrub belongs to *Euphorbiaceae* family same as rubber and cassava trees ((Srinophakun *et al.,* 2011, Grover *et al.,* 2013). Originally, *Jatropha curcas* was native tree in South America and was induced to Thailand about 200 years ago by Portuguese who produced soap from Jatropha oil. Generally, Jatropha tree is 3-6 meter tall, smooth grey bark, having latex and heart green leaf. *Jatropha curcas* L. or physic nut is a drought resistant large shrub or small tree, producing inedible oil containing seeds (Jongschaap *et al*, 2007). It is the commonest specie found in Nigeria, but many species exist in different parts of the world. It is a multipurpose, drought resistant tree and can be cultivated in areas of low rainfall (Mubonduri, 2012). *Jatropha curcas* L. is a suitable plant for quick and efficient domestication compared with other woody species (Achten, *et al*, 2010). Names used to describe the plant vary per region or country. It is most commonly known as "Physic nut‟. In Zimbabwe it is known as "Mufeta/ mujirimono" to mean it 'oil tree' (Mubonderi, 2012). In Nigeria it is known as "binidazugu/cinidazugu" and "lapa lapa" in Hausa and Yoruba languages respectively. (Blench, 2007 and Blench, 2003). At present, the varieties being used to established plantations in Africa and Asia are inedible (King *et al*, 2009). Due to its toxicity, *J. curcas* oil is not edible and is traditionally used for manufacturing soap and medicinal applications (Jongschaap *et al.*, 2007).

Taxonomic and Botanical description

The Euphorbiaceae family, which is considered one of the largest families of Angiosperms, covers about 7,800 species distributed in approximately 300 genera and 5 subfamilies worldwide. These species occur preferentially in tropical and subtropical environments (Webster, 1994 and Alves, 1998). Among the main genera belonging to this family, there is Jatropha L., which belongs to the subfamily Crotonoideae, Jatropheae tribe and is represented by about 200 species. This genus is widely distributed in tropical and subtropical regions of Africa and the Americas (Webster, 1994). The name "Jatropha" is derived from the Greek words "jatros," which means "doctor" and "trophe," meaning "food," which is associated with its medicinal uses. The leaves have significant variability in their morphology from green to pale green, alternate to sub opposite, and three- to five-lobed with a spiral phyllotaxis (Nahar and Ozores-Hampton, 2011). Flowers of *Jatropha curcas* produce nectar and are scented. The nectaries are hidden in the corolla and only accessible to insects with a long proboscis or tongue. The sweet, heavy perfume at night and greenish yellow colour of the flowers suggest that they are pollinated by moths.

Table 1: Taxonomic Classification *J. curcas* Linn

Kingdom:	Plantae
Subkingdom:	Angiosperms
Infrakingdom:	Streptophyta
Superdivision	Embryophyta
Division:	Tracheophyta
Subdivision:	Spermatophytina
Class:	Magnoliopsida
Superorder:	Rosanae
Order:	Malpighiales
Family:	Euphorbiaceae
Subfamily:	Crotonoideae
Tribe:	Jatropheae
Genus:	Jatropha
Species:	*Jatropha curcas* Linn

Source: http://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=28335

In inflorescences, the female flowers open one or two days before the male ones or at the same time as the earliest male flowers. Male flowers last only one day. Seed never sets in indoor cultivation unless the flowers are pollinated by hand. Plants raised from seed are more resistant to drought than those raised from cuttings, because they develop a taproot. Fruit development from flowering to seed maturity takes 80–100 days. Plants from cuttings produce seeds earlier than plants grown from seed. Full production is achieved in the 4th or 5th year (Henning, 2007).

Figure 1: Flower of *J. curcas* L.; **Sources:** (Lozano, 2007) and DEGJSP, 2012

Male and female flowers are produced on the same inflorescence, averaging 20 male flowers to each female flower (Oliveira *et al.,* 2009). The petiole length ranges from 6.1–23.1 mm. The inflorescence can be formed in the leaf axil. Plants are monoecious and also possess hermaphroditic flowers occasionally. Flowers are formed terminally, individually, with female flowers usually slightly larger occurring in hot seasons. Where continuous growth, an unbalance of pistillate or staminate flower production results in a higher number of female flowers. More female flowers mean more fruits. Fruits are produced in winter when the shrub is leafless, or it may produce several crops during the year if soil moisture is good and temperatures are sufficiently high. Each inflorescence yields a bunch of approximately 10 or more ovoid fruits. A three bi-valved cocci is formed after the seeds mature and the fleshy exocarp dries (Nahar and Ozores-Hampton, 2011). The seeds are mature when the capsule changes from green to yellow. The whole genome of *J. curcas* L was sequenced by *Kazusa DNA Research Institute*, Chiba Japan in October 2010 (DNA Res., 1994). Dahmer *et al.,* 2009 reported, somatic chromosome numbers were counted from root-tip cells of four individuals per population and all had 2n=22 chromosomes, corresponding to the diploid level (x=11) in which all the plant populations were found diploid. This lack of variation in chromosome numbers contrasts with the high variability in other characteristics such as seed size, weight, and oil contents due to environment and genetic interaction (Achten *et al.*, 2008).

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Fig2: *J. curcas* L with ripen fruits; source: (Warra, 2010)

Fig 3: *J. curcas* L with ripen fruits; source: (Warra, 2010)

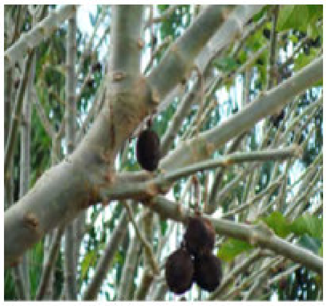

Fig 4: Dried fruits of *J. Curcas* L. (Mubonderi, 2012)

Fig 4: (a) Fresh and (b) dried seeds of *J. Curcas* L. Source: (Warra, 2010)

Ecological Requirements

Jatropha curcas grows almost anywhere, even on gravelly, sandy and saline soils. It can thrive on the poorest stony soil. It can grow even in the crevices of rocks. The leaves shed during the winter months (dry season) form mulch around the base of the plant (Arif and Ahmed, 2009). The organic matter from shed leaves enhance earth-worm activity in the soil around the root-zone of the plants, which improves the fertility of the soil. Regarding climate, *Jatropha curcas* is found in the tropics and subtropics and likes heat, although it does well even in lower temperatures and can withstand a light frost. Its water requirement is extremely low and it can stand long periods of drought by shedding most of its leaves to reduce transpiration loss. Jatropha is also suitable for preventing soil erosion and shifting of sand dunes.

Pests and Diseases

The seed oil, extracts of *J. curcas* seeds and phorbol esters from the oil have been used to control various pests, often with successful results. In Gabon, the seeds, ground and mixed with palm oil, are used to kill rats. The oil has purgative properties, but seeds are poisonous; even the remains from pressed seeds can be fatal (Orwa *et al.,* 2009). It is popularly reported that pests and diseases do not pose a significant threat to jatropha, due to the insecticidal and toxic characteristics of all parts of the plant. However, incidence of pests and diseases such as collar rot, leaf spots, root rot and damping-off, may be controlled with a combination of cultural techniques (for example, avoiding waterlogged conditions) and fungicides are widely reported (Srinophakun *et al.,* 2011). In Nicaragua (*Pachycoris klugii*) and India (*Scutellera nobilis*), causes flower fall, fruit abortion and seed malformation. Other serious pests include the larvae of the moth *Pempelia morosalis* which damages the flowers and young fruits, the bark-eating borer *Indarbela quadrinotata*, the blister miner *Stomphastis thraustica*, the semi-looper *Achaea janata*, and the flower beetle *Oxycetonia versicolor* (Arif and Ahmed, 2009). Termites may damage young plants. Carefully and judiciously adding an insecticide to the planting pit may be advisable if problems are endemic the use of pesticides is not necessary, due to the pesticidal and fungicidal properties of the plant. An insecticide may be included as a precaution against termites (Singh *et al.,* 2008).

1.4 Cultivation

J. curcas L. can be planted by two common methods; seed or seedling propagation and the cutting method (Jingura *et al.,* 2011). Prakash, 2006 reported that vegetative propagation can be achieved by stem cuttings, grafting, budding and by air layering techniques. The investigation leads to the recommendation that cuttings should be taken preferably from juvenile plants and treated with 200 microgram per liter of IBA (rooting hormone) to ensure the highest level of rooting in stem cuttings. These vegetative methods have potential for commercial propagation of these plants and yields faster results than multiplication by seeds (Arif and Ahmed, 2009). The plant can grow in wastelands and grows on almost any terrain, even on gravelly, sandy and saline soils (Brittaine and Lutaladio, 2010). Mycorrhizae have been observed on the roots; they promote growth, especially where phosphate is limiting (Henning, 2007). Complete seed germination is achieved within nine days. Adding manure during the germination has negative effects during that phase, but is favorable if applied after germination is achieved (Satish, 2007).

Fig 5a) Propagation of *J. curcas* by stem cutting

Fig 5b) Propagation of *J. curcas* by **grafting**

Fig5c) Propagation of *J. curcas* by air layering techniques

Source: Arif and Ahmed, 2009.

Jatropha curcas thrives on a mere 250 mm of rain a year, and only during its first two years does it need to be watered in the closing days of the dry season. Ploughing and planting are not needed regularly, as this shrub has a life expectancy of approximately forty years. Jatropha is planted at densities ranging from 1 1010 to 2500 plants per hectare. Yield per tree is likely to increase with wider spacing but with a decline in yields per hectare. (Achten, 2008). Spacing decisions should be based on the environment, i.e. how it affects competition among trees for water, light and nutrients. Semi-arid, low-input systems should use wider spacing such as 3.0 x 2.0, 3.0 x 2.5 or 3.0 x 3.0 metres. Alternate planting in succeeding rows will minimize mutual shading. In addition, consideration should be given to access. At least 2.5 m between trees allows easier passage for fruit pickers, while a 5-metre alley at every fourth row facilitates access by carts. Planting holes of 30–45 cm wide and deep should be prepared and organic matter incorporated before planting (Arif and Ahmed, 2009). In the case of vegetative propagation of *J. curcas,* the method uses 40-50 cm long cuttings. Unlike seedlings, cuttings are planted during the dry season mostly two to three months prior to the commencement of rainy season. This is mainly because the plant has so much water that it can decompose if planted during the rainy season (Mubondari, 2012). This has resonance with Henning (2009) who observes that the jatropha cuttings have a thin layer of wax that prevents the easy evaporation of water hence they have to be planted early to lose some water.

Growth and development

Growth in *Jatropha curcas* is intermittent and sympodial which is a zigzag pattern of growth following the architectural model of Leeuwenberg. Dormancy is induced by fluctuations in rainfall, temperature and light. Not all plants respond simultaneously; in a hedge plants without leaves may be found besides ones full of green leaves. The potential lifespan of *Jatropha curcas* is 30–50 years (Henning, 2007).

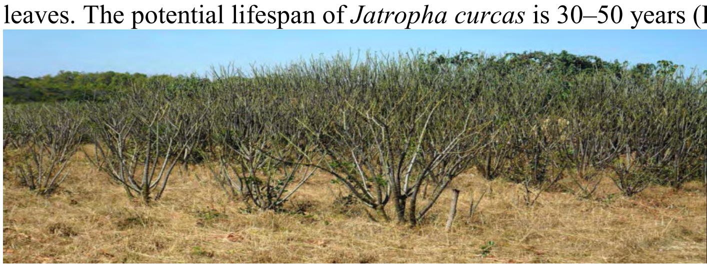

Figure 6: Sympodial i.e. a zigzag pattern of growth in which the main plant stem develops from a series of lateral branches.
Source: Mubonderi, 2012.

2. CHEMICAL COMPOSITION OF *JATROPHA CURACAS* L. COMPONENTS

2.1 Fruit shell:

The fruit shell describes the fruit pericarp, while the seed consists of the inner kernel and the outer husk or seed coat (Abreu, 2008). As stated in Farmers Handbook prepared in Kenya (DEGJSP, 2012) when the fruit is crushed by a simple hand tool, the shells and seeds are separated. The shell is mechanically removed from the fruit in the first step during oil extraction. The chemical analysis of *Jatropha curacas* L. shell has shown that it is made up of 34%, 10% and 12% cellulose, hemicellulose and lignin, respectively (Singh *et al*., 2008, Abreu, 2009). Volatile matter, ash and fixed carbon content of the shell have been shown to be 69%, 15% and 16%, respectively (Singh *et al*., 2008). These results show that *J. curcas* L. shells have very high ash content. This has an influence on the type of conversion technology that can be used to obtain energy from the shells. Jatropha shell ash fuses at temperatures above 750oc. Depending on the magnitude of the ash content, the available energy of the fuel is reduced proportionately (McKendry, 2002). At these high temperatures the ash reacts to form a slag, which can reduce plant throughput in combustion equipment. Sotolongo *et al*., 2009 reported that the caloric value of *J. curcas* L. shells is 11.1MJ kg-1. Singh *et al*., 2008 also found that the chemical composition of this plant shells seems to suggest that it is a good feedstock for biological conversion and for briquetting. Several conversion technologies have been studied using *J. curcas* L. shells as an energy feedstock. These include briquetting and combustion (Singh *et al*., 2008), pyrolysis (Manurung *et al*., 2009) and bio-methanation (Sotolongo *et al*., 2009).

2.2 Seeds

The matured seeds contain 21% saturated fatty acids and 79% unsaturated fatty acids (Gubitz *et al.,* 1999), and they yield 25%–40% oil by weight (Deng *et al.,* 2010). Additionally, the seeds contain other chemical compounds, such as saccharose, raffinose, stachyose, glucose, fructose, galactose, and protein. As stated by Achten *et al*., 2008. On average the seeds contain about 30-45% viscous oil which varies depending on where the jatropha is planted and the care it receives, water and nutrients (Jingura *et al.,* 2011).

2.3 Seed husks

According to (Abreu, 2008) the seed kernel contains predominantly crude fat oil and protein while the seed coat (husk) contains mainly fibre. Fig 8, shows that seed contains about 42% seed husks (seed coat) and 58% kernels, part of the seed in the seed coat. Although there is limited information in literature about the use of *J. curcas* L. seed husks for energy purposes. Analysis of the husks by Singh *et al*., 2009 and Vyas and Singh (2007) showed that the husks contained 4% ash, 71% volatile matter and 25% fixed carbon. The calorific value of the husks is 16 MJ kg-1, comparable to that of wood (Vyas and Singh, 2007). The physical properties of husks (for example, bulk density of 223 kg m-3) make them amenable to briquetting. The briquettes can be used as an energy source via combustion. Vyas and Signh, 2007 also stated that ***gasification*** is a mature commercial energy conversion technology that can be used with *J. curcas* L. seed husks. In this study, it was found that the ***syngas*** calorific value and concentration of carbon monoxide, along with gasification efficiency increased with the increase in gas flow rate. This study showed that seed husks can be successfully used as feedstock for open core down draft gasifier.

Seed cake:

Srinophakun *et al.,* 2011 discussed one liter of *J. curcas* L. oil comes from about 4 kg of seed which will give about 3 kg of the seed cake (a pressed seed cake, left after oil extraction).

Fig 7: Pressed seed

Jatropha curcas L. seed cake makes an excellent organic fertilizer with a high nitrogen content similar to, or better than, chicken manure with macronutrient contents such as Nitrogen % (4.4-6.5), P% (2.1-3.0), K% (0.9-1.7), Ca% (0.6-07) and Mg% (1.3-1.4) Patolia *et al.* (2007).

Jatropha curcas L. seed cake contains mainly proteins and carbohydrates. The cake is made up of the seed husks (42%) and kernel (Abreu, 2009). Based on the extraction efficiencies and the average oil content of the whole seed, press-cake can contain 9-12% oil by weight (Achten *et al*., 2008). This oil influences the gross energy value of press cake, which is about 18.2 MJ kg-1 (Achten *et al*., 2008). Production of biogas by anaerobic digestion of *Jatropha* press-cake has been demonstrated (Singh *et al*., 2008, Staubman *et al*., 1997).

Seed oil

The oil content of *J. curcas* seed generally lies in the range of 25–40 percent (Deng *et al.,* 2010). This can be extracted by heat, solvents or by pressure. The seed oil is potentially the most valuable end-product of *J. curcas*. Warra (2012) discussed that the plant seed oil chemically consists of triacylglycerol with linear fatty acid chain (unbranched) with/without double bonds. With related to this, two interesting forms of diterpenoids, namely Diterpenoid Curcuson A and Diterpenoid Curcuson C, having aromatic qualities are found in this plant. This is a great prospect for the plant in perfumes and other cosmetics industries. The oil is almost all stored in the seed kernel, which is accounted for around 58 % of the seed (Jongschaap, 2007). Similar result was obtained as the seed of this plant consists of 40-42% of husk and 58-60% of kernel by mass (Pandey *et al*., 2012). This compares well to groundnut kernel (42 percent), rape seed (37 percent), soybean seed (14 percent) and sunflower seed (32%). The seed yield can attain 4 tonnes of seed/ha/year while the oil yield can reach 1590kg/ha (Pradhan *et al.*, 2010; Silitonga *et al*, 2011).

The removal of shell from Jatropha seed can improve oil yield and quality during the oil extraction process in biodiesel production. A Jatropha shelling machine was evaluated to analyse its efficiency to separate between the seed and the shell (Lim *et al.,* 2014). Akbar, *et al* (2009) determined 63.16% oil content from

Malaysian *J. curcas* seed kernels using Hexane. High oil content of *J. curcas* indicated the plant is suitable as non-edible vegetable oil feedstock in oleochemical industries such as biodiesel, fatty acids, soap, fatty nitrogenous derivatives, surfactants and detergents.

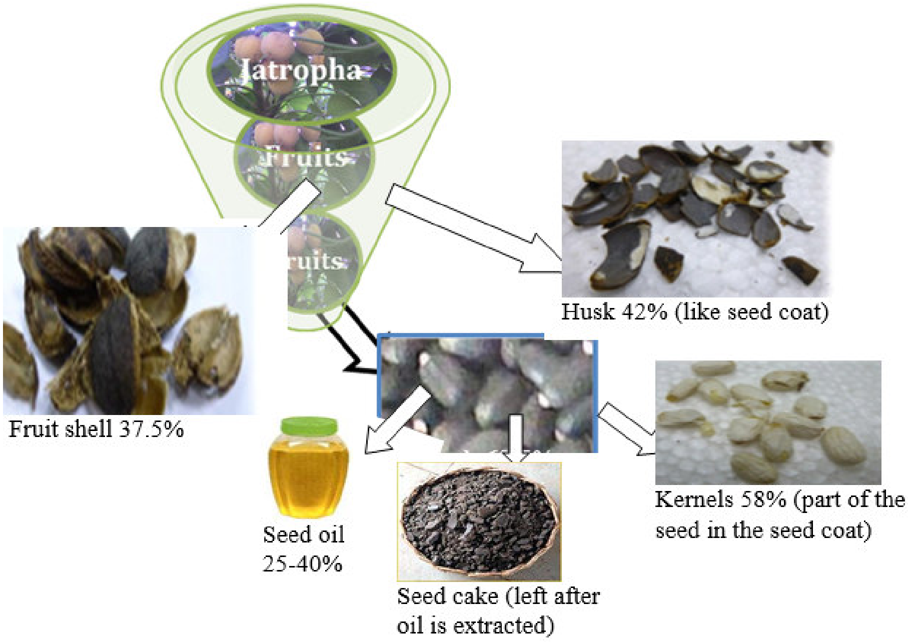

Fig 8: Harvested fruits products of *J. curcas* L. and their fractions by weight. Sources Abreu (2008), Deng *et al.,* 2010 and Lim *et al.,* 2014 a

Adebowale and Adedire (2006) reported in addition to a high oil content (64.4%), there are also lipid classes such as dominant triacylglycerol lipid species (88.2%) and appreciable percentage composition of fatty acids such as linoleic acid (47.3%) after extraction from samples of *Jatropha curcas* seeds obtained from markets in five different towns in Nigeria; as indicated below in Table 2 and 3.

Table 2: Percentage composition of lipid classes of *J. curcas* seed oil

R.No	Composition	Percentage
1	Unsaponifiable lipids	3.8
2	Stereo esters	4.8
3	Triglycerols	88.2
4	Free fatty acids (FFA)	3.4
5	Diacylglycerols	2.5
6	Sterols	2.2
7	Monoacylglycerols	1.7
8	Polar lipids	2.0

Table 3: Fatty acid composition of *J. curcas* seed oil

R.No	Composition	Percentage
1	Palmitic acid (C16:0)	11.3
2	Stearic acid (C18:0)	17.0
3	Oleic acid (C18:1)	12.8
4	Linoleic acid (C18:2)	47.3
5	Arachidic acid (C20:1)	4.7
6	Arachidoleic acid (C20:0)	1.8
7	Behenic acid (C22:0)	0.6
8	(C24:0)	44

Source: Adebowale and Adedire (2006)

Roots of *J. curcas* L. Contents

Ash from the roots and branches of *Jatropha curcas* L. is used as cooking salt, and as lye in dyeing. The dark blue dye extracted from the bark of Jatropha is a useful dye. HCN and *rotenone* are present in the roots of *J. curcas* L. (Marton, 1981). Ling-yi k. *et al.* (2015) in China isolated thirteen compounds from the roots of *Jatropha curcas* L. combining the determination of physico-chemical constants and spectral analyses (IR, 1H-NMR, 13C-NMR, EIMS, FABMS), the structures of the compounds were identified as 5α-stigmastane-3, 6-dione (1), nobiletin (2), β-sitosterol (3), taraxerol (4), 2S-tetracosanoic acid glyceride-1(5),5-hydroxy-6,7-dimethoxycoumarin (6), jatropholone A (7), jatropholone B (8), 6-methoxy-7-hydroxycoumarin (9), caniojane (10), 3-hydroxy-4-methoxybenzaldehyde (11), 3-methoxy-4-hydroxybenzoic acid (12) and daucosterol (13). Among them, compound 5 is a new compound which has never been reported in China and abroad, compound 1, 2, 9, 10, 11, 12 were first time isolated from the plant, 7 and 8 are a pair of stereoisomers which can be inverted in dilute basic solution. 10 is a diterpenoid containing peroxide bridge. The bark of *Jatropha curcas* L. contains a wax composed of a mixture of 'melissyl alcohol' and its melissimic acid ester (Orwa *et al*., 2009). Orwa *et al* (2009) reprted leaf juice stains red and marks linen an indelible black. The 37% tannin found in bark is said to yield a dark blue dye; latex also contains 10% tannin and can be used as marking ink. Ashes from the roots and branches are used in the dyeing industry, and pounded seeds in tanning in Ghana.

3. BIO-DIESEL POTENTIAL OF *JATROPHA CURCAS* L. OIL

The oil is mainly used as biodiesel for energy. The process through which the glycerin is separated from the biodiesel is known as transesterification. Glycerin is another by-product from Jatropha oil processing that can add value to the crop. Transesterification is a simple chemical reactionthat neutralizes the free fatty acids present in any fatty substances in Jatropha. A chemical exchange takes place between the alkoxy groups of an ester compound by an alcohol. Usually, methanol and ethanol alcohol are used for the purpose. The reaction occurs by the presence of a catalyst, usually sodium hydroxide (NaOH) or caustic soda and potassium hydroxide (KOH), which forms fatty esters (e.g., methyl or ethyl esters), commonly known as biodiesel. It takes approximately 10% of methyl alcohol by weight of the fatty substance to start the transesterification process (Ibeto et al 2011). The production of jatropha biodiesel is a chemical process whereby the oil molecules (triglycerides) are cut to pieces and connected to methanol molecules to form the jatropha methyl ester. An alkali normally sodium hydroxide (caustic soda) is needed to catalyze the reaction. Glycerine (glycerol) is formed as a side product. Methanol is normally used as the alcohol for reasons of cost and technical efficiencies. Sodium hydroxide is dissolved in methanol to form sodium methoxide, which is then mixed with jatropha oil. The glycerine separates out and is drained off. The raw biodiesel is then washed with water to remove any remaining methanol and impurities. Typical proportions used in the reaction are:

Inputs:

100 units of jatropha oil
10 -15units of methanol
0.5-2 units of NaOH catalyst

Outputs:

100 units of biodiesel
10-15 units of glycerine

The figure 9 below shows the chemical process for methyl ester, biodiesel. The reaction between the fat or oil and the alcohol is a reversible reaction, so the alcohol must be added in excess to drive the reaction towards the right and ensure complete conversion.

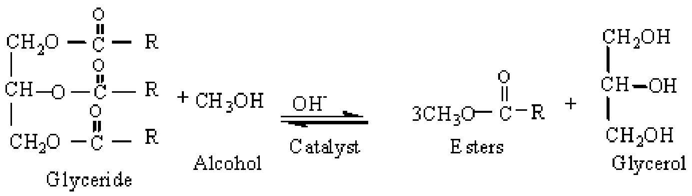

Fig 9: Chemical process for methyl ester, biodiesel.
Source: www.esru.strath.ac.uk/EandE/Web_sites/02-03/biofuels/what_biodiesel.htm

Here the biodiesel is produced in the form of methyl ester where as glycerine is the byproduct of it (Folaranmi, 2013). Concerning the production methyl ester (biodiesel) Berchmans and Hirat, 2008 found that there are two techniques to produce biodiesel from crude *Jatropha curcas* seed oil (CJSO). The first one is alkali base catalyzed transesterification process in which the presence of high concentration of free fatty acids, FFA, (15%) reduced the yield of methyl esters. The second is two-step pretreatment process in which the high level of JCSO was reduced to less than 1%. A two-stage transesterification process was selected to improve the methyl ester yield. Biodiesel may be used as partial blends (e.g. 5 percent biodiesel or B5) with mineral diesel or as complete replacements (B100) for mineral diesel. In general, B100 fuels require engine modification due to the different characteristics of biodiesel and mineral diesel. Van Gerpen *et al.* (2007) note specifically that solvent action may block the fuel system with dislodged residues, damage the hoses and seals in the fuel system, or cause cold filter plugging, poorer performance due to the lower heating value of biodiesel, some dilution of the engine lubricating oil, and deposit build-up on injectors and in combustion chambers. It is generally accepted by engine manufacturers that blends of up to 5 percent biodiesel should cause no engine compatibility problems. Higher blends than this may void manufacturers' warranties. Jatropha biodiesel has proven to conform to the required European and USA quality standards. Table 5 shows that jatropha biodiesel generally exceeds the European standard. For every 1 litre of biodiesel, 79 millilitres of glycerine are produced, which is equivalent to around 10 percent by weight. The raw glycerine contains methanol, the sodium hydroxide catalyst and other contaminants, and must be purified to create a saleable product. Traditional low volume/high-value uses for glycerine are in the cosmetic, pharmaceutical and confectionary industries, but new applications are being sought as productionshifts to high volume/low value. Glycerine is used in the production of fuel, plastics and antifreeze Francis *et al.* (2005). Pure jatropha oil may be used directly in some diesel engines, without converting it into biodiesel. The main problem is that jatropha oil has higher viscosity than mineral diesel, although this is less of a problem when used in the higher temperature environment of tropical countries. The following are the available options for using jatropha oil in diesel engines.

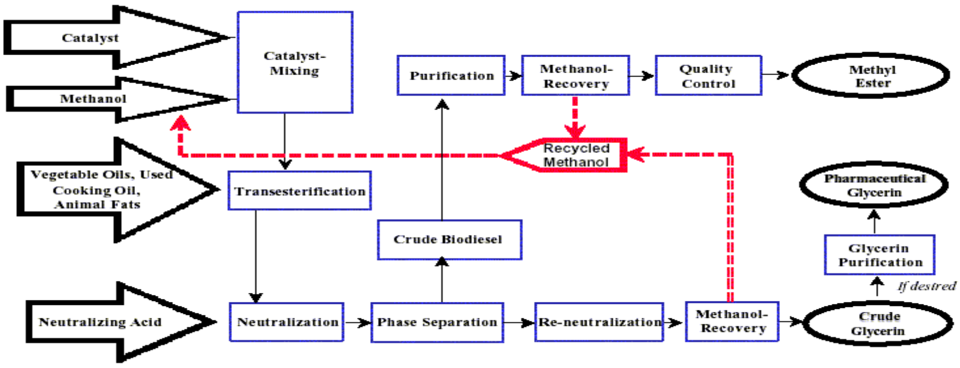

Figure 10: General Schematic diagram for Production of Bio-diesel from *J. curcas* and other inputs;
Source: Folaranmi, 2012

Indirect-injection engines: Some indirect-injection diesel engines of older design, such as the Lister single cylinder engines, can use jatropha oil without any problems. These engines, made in India, require no modification other than an appropriate fuel filter. In fact the higher oxygen content of the jatropha oil can deliver greater power under maximum load than diesel. These engines can be run on jatropha oil, biodiesel, mineral diesel or a blend.

Two-tank system: The power unit may be modified to a twotank system. This is effectively a flex-fuel power unit which may run on mineral diesel, any blend of biodiesel or on vegetable oil. The problem of cold starting with the more viscous vegetable oil is avoided by starting and stopping the engine using diesel or biodiesel and then switching tanks to run on the oil when it reaches the critical temperature. Detergents in the mineral diesel prevent the build-upof carbon deposits and gums in the pump and on the fuel injectors. Switching between fuels may be manual or automatic.

Single-tank vegetable oil system: A single-tank vegetable oil system uses fuel injectors capable of delivering higher pressures to overcome the high oil viscosity, stronger glow plugs, a fuel pre-heater and a modified fuel filter. A number of manufacturers produce engines that use these single and two-tank technologies. The addition of proprietary organic solvents to the vegetable oil is sometimes recommended to improve engine performance. The long-term viability of these systems in terms of engine performance and reliability remains to be fully assessed. The oil must be of a quality satisfactory for long-term performance of engines run on jatropha oil. Although fresh jatropha oil is low in free fatty acids, it must be stored in closed, dry, cool conditions. The presence of particles and phosphorous in the oil can block filters and cause engine wear. Phosphorous content is lower when the oil is pressed at temperatures less than 60°C. The oil should be well filtered (five microns) to remove contaminants and its water content kept as low as possible to reduce corrosion and wear in the engine, and avoid build up of microbial growth in the fuel delivery system (de Jongh and Adriaans, 2007). Jatropha oil has been found adequate for use as a crankcase engine lubricant in Lister-type diesel engines. Crude jatropha oil is relatively viscous, more so than rapeseed. It is characteristically low in free fatty acids, which improves its storability, though its high unsaturated oleic and linoleic acids make it prone to oxidation in storage. The presence of unsaturated fatty acids (high iodine value) allows it to remain fluid at lower temperatures. Jatropha oil also has a high cetane (ignition quality) rating. The low sulphur content indicates less harmful sulphur dioxide (SO_2) exhaust emissions when the oil is used as a fuel. These characteristics make the oil highly suitable for producing biodiesel.

USES OF *JATROPHA CURCAS* L.

a. As substitute of fossil diesel

Achten *et al*., 2008 extensively studied that seed oil from the plant is used as an alternative stationary engine or transportation fuel. This is due to its potential to substitute fossil diesel. The calorific value of seed oil is 39MJ kg-1 which is higher than anthracite coal and comparable to crude oil (Sotolongo *et al*., 2009). Raw oil has been used as a substitute for petro-diesel both in modified and unmodified diesel engines. The fuel properties of seed oil are shown in Table 2. It can be seen from Table 2 that seed oil has high kinematic viscosity. The viscosity of raw oil is 41.5mm2 sec-1 compared to the ASTM standard requirement for diesel fuel which is 1.3-4.1mm2 sec-1 (Kywe and Oo, 2009). As a resultant, the use of raw oil in diesel engines has not shown satisfactory results due to its high viscosity (Shahid and Jamal, 2008). High viscosity of raw oil causes problems in its use in diesel engines. These include reducing the fuel atomization and increasing fuel spray, which would be responsible for engine deposits, injector coking, piston ring sticking and thickening of lubricating oil (Kywe and Oo, 2009; Shahid and Jamal, 2008). Despite the problems caused by its high viscosity for use in diesel engines, raw oil can have some other energy uses. It has been used in slow-speed stationary diesel engines such as pumps and generators with success (Tomomatsu and Brent, 2007). Prasad *et al*. (2000) reported that tests with low heat rejection diesel engine showed that use of JCL oil results in higher brake specific energy consumption (BSEC), lower brake thermal efficiency (BTE), higher exhaust gas temperature (EGT) and lower NO_x emissions than fossil diesel. The reduction in NO_x emission has environmental benefits. Pre-heating and blending raw oil with fossil diesel are techniques that have also been used to improve the use of raw *Jatropha curcas* L as a fuel (Achten *et al*., 2008). Both techniques have the effect of reducing the viscosity of the seed oil.

b. As source of Biogas

Biogas has been produced from fruit shells. In addition, trials showed that seed husks can be used as a feedstock for a gasification plant (Staubmann *et al*., cited Achten *et al*., 2008). *Jatropha curcas* L fruit shells and seed husks can be used for direct combustion. Since the shells make up around 35–40 percent of the whole fruit by weight and have a calorific value approaching that of fuelwood, they could be a useful by-product of jatropha oil production. As shown in TABLE 4 The calorific values of *Prosopis juliflora* (a fuelwood species of semi-arid areas) and jatropha fruit shells are similar. However, four times the volume of fruit shells is required to equal the heating value of fuel wood, due to their lower bulk density. The seed cake has a high energy content of 25MJ kg-1. Experiments have shown that some 60 percent more biogas was produced from jatropha seed cake in anaerobic digesters than from cattle dung, and that it had a higher calorific value (Abreu, 2008).

Table 4: The calorific values of *Prosopis juliflora* (a fuelwood species of semi-arid areas) and jatropha fruit shells

	Wood (Prosopis juliflora)	**Biomass Briquettes**	**Jatropha fruit shell**	**Jatropha seed husk**
Bulk density Kg/m3	**407**	**545**	**106.18**	**223.09**
Ash content % dm	**1.07**	**8.7 7**	**14.88**	**3.97**
Caloric value Kcal/kg	**4018**	**4130**	**3762**	**4044**

Adapted from: Abreu (2008)

Seed husks have a higher heating value and greater bulk density which makes them more valuable than the fruit shells as a combustible fuel. However, the technology required to separate the seed husk from the kernel is more suited to large processing plants than small rural industry. The fruit shells can be dried and ground to a powder and formed into fuel briquettes. A trial found that 1 kg of briquettes took around 35 minutes for complete combustion, giving temperatures in the range of 525ºC–780ºC (Singh *et al.*, 2008). The ash left after combustion of jatropha shell briquettes is high in potassium, which may be applied to crops or kitchen gardens. The fruit shells and seed husks also can be left around jatropha trees as mulch and for crop nutrition. For jatropha grown on degraded land, this has clear advantages because nutrient re-cycling – through returning the seed cake to the plantation – is unlikely to happen, due to the effort required and the higher utility to be gained from applying the seed cake to high-value crops.

c. For varnish preparation

Oil is used to prepare **varnish** after calcination with iron oxides. Hardened physic nut oil could be a satisfactory substitute for tallow or hardened rice bran oil. In Europe it is used in wool spinning and textile manufacture. Along with burnt plantain ashes, oil is used in making hard homemade soap (Orwa *et al*., 2009).

d. Human consumption

Jatropha can be toxic when consumed due to the seeds contain toxic Phorbol esters. However, a non-toxic variety of Jatropha is reported to exist in Mexico and Central America, (Makkar et al.1998; Misra and Misra, 2010). This variety is used for human consumption after roasting the seeds/nuts, and "the young leaves may be safely eaten, steamed or stewed." They are favored for cooking with goat meat, said to counteract the peculiar smell. This non-toxic variety of Jatropha could be a potential source of oil for human consumption, and the seed cake can be a good protein source for humans as well as for livestock (Makkar and Becker 1999; Aregheore 2003).

***Jatropha curcas* L oil in Household activities**

Traditionally, it is used for the manufacture of candles and soap, as lamp oil and as fuel for cooking. It is a poor lubricant as it dries quickly. Throughout the tropics and warm subtropics *Jatropha curcas* is increasingly planted for bio-fuel purposes. The oil is either used directly in adapted engines powering local grain mills, oil presses, water pumps and small generators, or first refined by trans-esterification with methanol or ethanol to produce regular fuel suitable for high-performance diesel engines.

Light/ lamp: The oil is put in a small container and a wick is dipped in through the top lid to make a lamp. Alternatively, the jatropha seed can be joined with a thin wire and when the top seed is lit it can slowly burn, producing light. This method is commonly used especially when a household does not have money to buy another alternative light source. The problem of jatropha oil's high viscosity also applies to lamp design. A lamp with a floating wick offers one solution to the oil's poor capillary action. This allows the wick to be kept as short as possible, with the flame just above the oil. The oil lamp requires a very short wick so that the flame is very close to the oil surface. It requires periodic cleaning of the wick to remove carbon deposits. Ordinary kerosene lamps may be modified to lower the wick, but the oil level has to be maintained at a constant level and the wick again needs frequent cleaning. There is anecdotal evidence that using a jatropha oil lamp deters mosquitoes

(Brittaine, 2010). It can also be used as an illuminant in lamps as it burns without emitting too much smoke.

Figure 11a): Oil lamp extracted from jatropha oil

Figure 11 b): special,Kakute stove works by jatropha oil R MAHAJAN - 2009

Cooking fuel: Raw oil can also be used as a substitute for kerosene in lamps and cooking stoves. However, these will need to be modified to account for high oil viscosity and low absorbance capacity (Tomomatsu and Brent, 2007)**.** There are clear advantages to use plant oil instead of traditional biomass for cooking. These include health benefits from reduced smoke inhalation, and environmental benefits from avoiding the loss of forest cover and lower harmful Green House Gas, GHG, emissions, particularly carbon monoxide and nitrogen oxides. The high viscosity of jatropha oil compared to kerosene presents a problem that necessitates a specially designed stove. In Zimbabwe, Mutoko district, Kakute, an NGO provided out-grower farmers with cooking stoves called 'Kakute stove' that uses jatropha oil and it proved to be beneficial to local people (Van Eijck and Romijn, 2008; Marjolein and Romijn, 2010).

Soap making

Jatropha oil has a very high saponification value and is ideal for soap manufacture. Soap manufactured from non-petroleum sources is gaining increasing popularity especially in the European countries. Jatropha oil has a very high saponification value and is ideal for soap manufacture. Soap manufactured from non-petroleum sources is gaining increasing popularity (Lozano, 2007). Jatropha soap is made by adding a solution sodium hydroxide (caustic soda soda) to jatropha oil. This simple technology has turned soap making into a viable small-scale rural enterprise appropriate to many rural areas of developing countries. The glycerin that is a by-product of biodiesel can be used to make soap, and soap can be produced from Jatropha oil itself. It will produce a soft, durable soap, and the rather simple soap making process is well adapted to household or small-scale industrial activity.In many countries, Jatropha oil is known for its usage for soap making (Arif and Ahmed, 2009). It has been used commercially for soap manufacture for decades, both by large and small soap producers. Soap produced from jatropha is sold as a medical soap, effective in treating skin ailments. In former times Portugal imported Jatropha seeds from Cape Verde Islands to produce soap (Fact Foundation, 2006). In India, Nepal and Zimbabwe the prize of tallow or the prize of Jatropha and other plant oils is at least 2.5 times the selling prize of diesel. Obviously, selling Jatropha oil for soap making is far more profitable in these countries than using it as a diesel or kerosene substitute. (Openshaw, 2000). Warra, 2012 stated that in GUANTANAMO, Cuba - Farming families in El Oro community, located in the semi-arid region of this eastern Cuban province, have been successful in making soap from the extracted oil from the *Jatropha curcas* tree. Henning (2004) noted that jatropha soap is sold in dispensaries at a higher price than other soaps on the market. In addition to soap making, if one became acquainted to the right mixtures, the jatropha oil is also used to condition hair; the oil is a good chemical for relaxing hair giving it a fine straight finish (Mubondari, 2012).

As a source of Fertilizer: The residue from the biogas digester can be used further as a fertilizer. Where cow dung is used for household fuel, as in India, the seed cake can be combined with cow dung and cellulosic crop residues, such as seed husks, to make fuel briquettes. The seed cake of the plant can be used for biomass feedstock to power electricity plants, or as biogas or highquality organic fertilizer (Achten et al., 2008; Ghosh et al. 2007; Patolia *et al.,* 2007).

Jatropha as fodder

Jatropha also contains curcasin, arachidic, linoleic, myristic, oleic, palmitic, and stearic acids and curcin (Perry 1980). Curcin and phorbol ester aretoxic compounds contained in the Jatropha meal. However, the meal can be suitable for animal feed after a detoxification process (Gaur et al. 2011). As livestock feed Jatropha seed cake is high in protein – 58.1 percent by weight compared to soy meal's 48 percent – and would be a valuable livestock protein feed supplement if it were not for its toxicity. Currently, removal of toxins is not commercially viable. Using non-toxic varieties from Mexico could make greater use of this potentially valuable by-product, but even these varieties may need treatment to avoid sub-clinical problems that could arise with long-term feeding of jatropha seed cake to livestock (Makkar and Becker, 1997). Curcin and phorbol ester aretoxic compounds contained in the Jatropha meal. However, the meal can be suitable for animal feed after a detoxification process (Gaur et al. 2011). Due to the fact that the seeds of *J.curcas* contains some toxins compounds such as those reported by (King *et al*, 2009) a protein (curcin) and phorbol-esters (diterpenoids), other researchers (Goel, *et al*, 2007) suggested that the detoxification or complete removal of phorbol esters is essential before its use in industrial or medicinal applications. The major toxin phorbolester is not vulnerable to heat, but can be hydrolyzed to less toxic substances extractable by either water or ethanol. (Usman, *et al*, 2009). Aregheore *et al*. (2003) employed heat treatment, alkaline hydrolysis and solvent extraction for the detoxification of the *Jatropha curcas* seed cake. King *et al*, 2009 reported that despite the toxicity of *J. curcas*, edible varieties are known to exist in Mexico which are not currently being exploited.

Medicinal Properties of Jatropha Plant

Jatropha species are used in traditional medicine to cure various ailments in Africa, Asia, and Latin America or as ornamental plants and energy crops [3]. Several known species from genus Jatropha have been reported for their medicinal uses, chemical constituents, and biological activities such as Jatropha curcas, Jatropha elliptica, Jatropha gossypiifolia,andJatropha mollissima,amongothers (Sabandar *et al.*2013). Although the leaves are toxic when consumed, the green pigment that comes out of the leaves and the latex that comes from the stem can be used to stop bleeding wounds on both humans and livestock. Apart from being used as a live fence, the plant is used as a repellant agent. Some people believe that jatropha protects the home from evil spirits and snakes. In Mutoko, Zimbabwe, witchcraft is a common social phenomenon hence jatropha is believed to have the power to repel witches and bad omens (Mubondari, 2012).

The latex of Jatropha contains jatrophine, an alkaloid which is believed to have anti-cancerous properties. It is also used as an external applicant for skin diseases, rheumatism, livestock sores, piles and as an antidote for certain snake-bites The dark blue dye extracted from the bark of Jatropha is a useful dye. Jatropha oil cake is rich in nitrogen, phosphorous and potassium and can be used as organic manure. Jatropha leaves are used as food for the tusser silkworm. The seeds are considered anti helmintic in Brazil, and the leaves are used for fumigating houses against bed bugs. In addition, the ether extract shows antibacterial properties against Staphylococcus aureus and Escherichia coli (Lozano, 2007). Medically it is used for diseases like cancer, piles, snakebite, paralysis, dropsy etc (Nahar and Ozores-Hampton, 2011). Protein, constituting 18.2% of the mass of Jatropha curcas seed, is mainly made up of curcin; curcin toxicity is similar with that of ricin in Ricinuscommunis seeds and crotin in *Croton tiglium* seeds (Stirpe et al. 1976). Curcin, also named *Jatropha curcas* ribosome inactivating protein (RIP), is a RNA n-glycosidase that can cause inactivation of eukaryotic ribosomes and inhibition of protein syntheses (Juan Lin et al. 2002). It can effectively inhibit the in vitro proliferation of human gastric cancer cells (SGC-7901), murine myeloma cells (Sp20), and human hepatoma cells (Juan Lin et al. 2003a). The full-length cDNA sequence (GenBank Accession Number AY069946) and gene sequence (GenBank Accession Number AF469003) of curcin have been cloned in *Escherichia coli* cells and expressed into bioactive mature proteins with conserved protein domains (Juan Lin et al. 2003b). Yu Chen et al. (2003) screened for two kinds of protein from Jatropha curas seeds. One of them is a 28kD anticancer protein, which suppresses the activity of ribosome and is thereby curcin.

The roots, bark, leaves and seeds of J. curcas are used for medicinal purposes. J.curcas seeds are characterized by its anti-inflammatory, and anti-swelling effects. J. curcas seed oil can be used as a laxative, and is also widely used for treating various skin diseases, and for pain relief, including rheumatic diseases. Overdose of J. curcas seed oil could lead to diarrhea and gastroenteritis (Marraquin and Blanco, 1997). *J. curcas* seeds have been found to exhibit significant anti-cancer activity. The seeds also possess value for use as an industrial oil, prevention of pests and plant diseases; it is also shows promising pharmaceutical value. J. curcas is also an excellent species for domestication in hot and barren mountainous lands at river valley areas. With advances in basic research and further industrialization of J. curcas domestication, it is expected that J. curcas will hold an exceptional economical value to China.

The latex has a widespread reputation for healing wounds, as a haemostatic and for curing skin problems; it is applied externally to treat infected wounds, ulcers, ringworm, eczema, dermatomycosis, scabies and sarcoptic mange in sheep and goats. The latex is discharged from the bark when the plant is cut and it is white and watery (Nahar and Ozores-Hampton, 2011). The latex of Jatropha contains jatrophine, an alkaloid which is believed to have anti-cancerous properties. It is also used as an external applicant for skin diseases, rheumatism, livestock sores, piles and as an antidote for certain snake-bites Upon drying, the initially viscous latex forms an airtight film, resembling that produced by collodion. The latex has a styptic effect and is used against pains and stings of bees and wasps. Dried and pulverized root bark is made into poultices and is taken internally to expel worms and to treat jaundice. Leaves are also applied on wounds and in decoction they are used against malaria in Mali and Madagascar, while in Benin and Réunion a decoction is taken against hypertension. The leaf sap is used externally to treat haemorrhoids in Benin and Madagascar. In Guinea Bissau a hot water extract of the leaves is taken orally to accelerate secretion of milk in women after childbirth. Fresh stems are used as chew sticks to strengthen the gums, and to cure bleeding, spongy gums or gum boils. A decoction of the roots is a cure for diarrhoea and gonorrhoea. In Madagascar a decoction of the leaves and roots is taken to treat malaria. *Jatropha curcas* is also used in the preparation of arrow poison and in the Philippines the bark is used to prepare a fish poison. The seeds are often a source of accidental poisoning, both in animals and humans.

Leaf sap yields a black dye or ink that is said to be indelible; the bark yields a dark blue dye, which, however, is not fast. *Jatropha curcas* is widely cultivated in the tropics as a living fence, for erosion control, demarcation of boundaries and for protection of homesteads, gardens and fields against browsing animals. In Madagascar and elsewhere in Africa it serves as a support for vanilla, black pepper and yams. The seed cake left after oil extraction is too toxic to be used as animal feed, but constitutes a valuable organic fertilizer rich in nitrogen. Some accessions of *Jatropha curcas*found e.g. in Mexico are almost free of toxins and the seed cake from such selections would provide a nutritious feedstock on account of the high protein content. Their seeds are sometimes boiled or roasted and eaten as a snack and young leaves as a vegetable. Jatropha oil has molluscicidal properties against the vector snails of the *Schistosoma* parasite that causes bilharzia. The emulsified oil has been found to be an effective insecticide against weevil pests and house flies, and an oil extract has been found to control cotton bollworm and sorghum stem borers (Gubitz, 1999). Achten *et al.*, 2008 describe the use of oil extracts as an insecticide, molluscicide, fungicide and nematicide. These potential uses have yet to be commercialized. As previously mentioned, the oil is widely used as a purgative in traditional medicine. Extracts from grounded *J. curcas* seeds exhibit insecticidal activity in snails carrying Schistosoma worms (Juan Lin and et al., 2004). Jatropha leaves are used as food for the tusser silkworm. The seeds are considered anti helmintic in Brazil, and the leaves are used for fumigating houses against bed bugs. The ether extract shows antibacterial properties against Staphylococcus aureus and Escherichia coli. Li *et al.* (2004) extracted curcin, seed oil and ethanol extracts from J. curcas seeds and investigated the insecticidal activity against Lipaphis erysimi.

Table 5: Parts of *J. curcas* L. to be used

Parts of *J. curcas* L. to be used		**Uses**	**References**
Fruits hulls		-Combustibles	Brittaine, R., and N. Lutaladio. 2010.
		- Green Manure	(Orwa *et al.,* 2009)
		-Biogas production	Achten et al., 2008; Ghosh et al. 2007; Patolia *et al.,* 2007
Seeds	Seed oil	Soap production	Warra, 2012
		Fuel	Satish Lele, 2007
		Insecticide	Srinophakun *et al.,*2011; Achten *et al.*, 2008
		Medicinal uses	Li *et al.* (2004)
	Seed cake	Fertilizer	Achten et al., 2008; Ghosh et al. 2007; Patolia *et al.,* 2007
		Biogas production	Staubmann *et.al.,* 1997; Achten et al., 2008; Ghosh et al. 2007; Patolia *et al.,* 2007
		Fodder (from non toxic varieties)	(Gaur et al. 2011).
	Seed shell	Combustibles like fruit hulls	Brittaine, R., and N. Lutaladio. 2010.
Leaves		To develop Eri Silkworm	Lozano J. A. D., 2007
		Medicinal uses	(Orwa *et al.,* 2009)
		Anti-inflammatory substance	Warra, 2012
Latex		Contains wound healing protease (Curcain)	(Orwa *et al.,* 2009)
		Medicinal Uses	(Nahar and Ozores-Hampton, 2011)

The results showed that curcin had no significant insecticidal effects on *L. erysimi*; however, *J. curcas* seed oil showed high toxicity, and ethanol extracts showed a higher pesticidal activity than seed oil. The authors found that 2.02 g/L of ethanol extracts exhibited significant biological control of Lipaphis erysimi; biocontrol efficacy was as high as 72.11% after 7 days of treatment. Wei et al. (2004) tested the fungicidal effects of curcin with Magnaporthe grisea, Pestalotia funerea, Rhizoctonia solani and Sclerotinia sclerotiorum. The results showed that 5 ug/mL can significantly inhibit the growth of fungal mycelium and spore germination. When the concentration was increased to 50 ug/mL, there was no significant M. grisea spore formation and the inhibition rate of P. funerea reached as high as 83.8%. Following treatment, mycelial cells showed evident shrinkage and deformation under light microscope; SDS-PAGE analysis further confirmed decreased protein band intensity in mycelial cells. The results demonstrated that inhibition of both mycelial growth and sporulation may be due to an inhibitory effect of curcin on protein synthesis. Brittaine R., 2010 reported that by providing physical barriers, jatropha can control grazing and demarcate property boundaries while at the same time improving water retention and soil conditions.

CONCLUSION:

The objective of this review paper focuses some basic aspect of the taxonomic, biology, cultivation, chemical composition, bio-diesel potential, medicinal values and uses of Jatropha curcas Linn. The entire *J. curcas* plant can be used for medicine. It can also be used to refine bio-diesel. These benefits cannot be overlooked in the growing need for clean and efficient biofuels. *J. curcas* are also semi-succulent plants, shedding leafs during prolonged arid conditions, and can easily adapt to arid- and semi-arid ecological systems. They will not compete with crops for arable land, since their requirements for soil nutrition are very low. Taken together, cultivation of Jatropha curcas, particularly in areas that suffer severe soil and water loss, has ecological significance for both soil and water conservation. Nevertheless, the ecological effects of large-scale cultivation of *J. curcas* on natural requires evaluation. *J. curcas* seeds exhibit, toxicity and can be used to develop new lead compounds. The probability of developing new medical compounds with high efficiency and low toxicity directly from plants is low. Actions on *J. curcas* seeds to remove its toxicity should allow drug discovery of its active constituents. J. curcas seeds possess significant economic value, but research on its seed development, storage, germination characteristics, and high-yield cultivation, remains rare. Further reseach studies that can improve the production, oil content yield, combustibility, and decrease the toxicity of the plant will provide a clearer understanding of its practical benefits.

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