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Review Paper on Origin, Description, Distribution and Economic Importance of *Jatropha curcas*

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Abstract

Jatropha curcas is a multipurpose plant with many desirable attributes and considerable potential. It is a tropical plant that can be grown in low to high rainfall areas and can be used to reclaim land, as a hedge and/or as a commercial crop. *Jatropha curcas* is attractive for many reasons: it is a renewable energy source; balances CO_2 in environment; produce less harmful emissions than fossil fuel; the fuel production technology is simple; it is a non-edible oil source; is a perennial crop having a 30 year long life span; high oil content in seeds comparative to other biodiesel sources; is a disease-resistant plant; is not over-sensitive to climatic change; can be grown in arid areas; and due to its dormancy characteristics, it survives in various weather conditions. It is a multi-purpose, shrubby, tree belonging to the Euphorbiaceae family. It is native to Mexico or Central America, but now thrives in many parts of the tropics and sub-tropics in sub-Saharan Africa and Asia. Jatropha has received tremendous attention around the world over the past several years due to its potential as a biofuel crop. However, many of the claims made regarding Jatropha including wide adaptability to diverse climatic zones and soil types, short gestation period, easy multiplication, drought tolerance, not competing with food production, and pest and disease resistance have proven highly exaggerated.

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Introduction

Jatropha is a species of flowering plant in spurge family, Euphorbiaceae, that is native to the American tropics, most likely Mexico and Central America (Janick, Jules, Robert E. Paull, 2008). It is cultivated in tropical and subtropical regions around the world, becoming naturalized in some areas. The specific epithet, “curcas”, was first used by Portuguese doctor, Garcia de Orta more than 400 years ago and is of uncertain origin. Common names include Barbados nut, purging nut, physic nut, or JCL abbreviation of *Jatropha curcas* Linnaeus. *Jatropha curcas* (2009). The seed contains 27-40% oil (average: 34.4%) that can be processed to produce a high- quality biodiesel fuel, usable in a standard diesel engine (Achten *et al.*, 2008). *Jatropha curcas* tree can easily be propagated by cutting and is widely planted as hedges to protect field erosion. It is a drought resistant and can grow in gradually sandy saline soil. This plant can grow up to 6 metres; it has large green to pale green leaves and can produce seeds up to 35 years (Mohammed *et al;* 2012). The seed of jatrophas is oval in shape and black in colour. The oil produced from the seed of jatropha is golden yellow in colour. The genus jatropha contains approximately 175 known species. The genus named jatropha derived from the Greek words jatros (Doctor), jatrophe (food) which implies medicinal uses. *Jatropha curcas* thrives in poor, stony soil and under adverse climatic conditions. It has numerous common names depending on the country where it is found, but is mostly referred to as physic nut or purging nut (Openshaw, 2000). *Jatropha curcas* is a plant that has many attributes, it uses are numerous; it is a multipurpose plant that have various numerous benefits. It belongs to the euphorbiaceae or spurge family. It is an uncultivated, non-food, wild species. It is a plant with many attributes, multipurpose uses and considerable potential (Openshaw, 2000; Sachdeva *et al.,* 2012).

Origin, Botanical Description and Economic Importance of Jatropha

Origin

It is still uncertain where the center of origin of *J. curcas* is, but it is believed to be a native of Mexico and the Central American region. It has been introduced to Africa and Asia and cultivated world-wide in many parts of the tropics and subtropics where it is grown as a hedge crop and for traditional use (Heller, 1996; Kumar and Sharma, 2008).

Names used can also vary (English- physic nut, purging nut; Hindi - ratanjyot, jangli erandi; Malayalam - katamanak; Tamil - kattamanakku; Thailand - tuba, Gujarathi - jepal; Sanskrit - kanana randa, Indonesia - jarak pagar, Malay - jarak etc.), according to region/country. It is most commonly known as “physic nut” or “hedge castor oil plant”.

Botanical description and habitat

Puangpaka and Thaya (2003) conducted an experiment on the karyology of five Jatrophaspecies including *J. curcas* in Thailand. Their finding indicated that *Jatropha curcas* haschromosome numbers of 2n = 2x = 22 and a basic chromosome number of x = 11.

Jatropha curcas L. is a small tree or a large shrub which can achieve a height of 5 meter and rarely can attain a height of 10 meter under favorable conditions. The plant shows articulated growth, with a morphological discontinuity at each increment. It is drought resistant species and known as an arid and a semi-arid plant species (Heller, 1992). *Jatropha curcas* is a deciduous plant and the stem has smooth gray bark which exudes white watery latex during injury. Jatropha leaves have narrow lobes and are arranged on stem and branches in an alternate manner. The length and width of the leaves highly vary and morphologically it is similar to *Ricinus communis* L. leaves. It grows mainly primary and secondary branches which are arranged alternately

Distribution/Expansion of Jatropha

J. curcas L. in (physic nut, purging nut), a tropical plant originated from Central America but has been naturalized in most tropical and subtropical countries from South-America to Africa and Asia. Its tolerance of various soil and climatic conditions allows its vast distribution within the so called “*Jatropha* belt” stretching between 30° N and 35° S (Jongschaap *et al.*, 2007).

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 from 250 to over 1200 mm per annum (Katwal and Soni, 2003). It occurs mainly at lower altitudes (0 to 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.

In Ethiopia, jatropha is grown traditionally for the same purposes and found abundantly in different areas, for example in Gamo Goffa, Gurage, Hadiya, Silte, Dawuro, Sidama and Mirab Abaya of Southern nations nationalities and people region; ShoaRobit, Matama, Gojjam area and Bati of the Amhara region;Alamata, Kola Tenben, Central Tigray of Tigray region, Metekel in Benishangulgumuz region and Adama area, Kelam Wollaga (Dale and Lalo Kile area), East Wollaga (Sasiga), East Hararge (Babile), West Hararge (Meiso), Jima (Goma), Bale (Delomana and Medawalabu), Borena (Abaya), East Hararge (Babile), Ilu abba bora (Boracha), Wolenchiti and Upper Awash in the Oromia Regions (Getinet, 2010).

Jatropha growing climate and soil

Jatropha curcas is adapted to a wide range of climates and soils. It can grow almost on any type of soil whether gravelly, sandy or saline and thrives even on the poorest stony soils and rock crevices. To combat phosphate deficiency it avails of the symbiosis with root fungi (Mycorrhiza). The leaves shed in winter months form a mulch around the plant base and organic matter there from enhances earthworm populations around the root-zone of the plants, a fair indicator of improvement in micro fauna and soil fertility.

Climatically *Jatropha curcas* prefers the warmer regions of tropics and sub-tropics, although it does well even in slightly cool conditions and can withstand a high frost. It water requirement is extremely low and withstands long periods of drought by shedding most of its leaves to reduce transpiration losses. The organic mulch around the base of the plant formed by the fallen leaves also considerably reduces water loss due to surface evaporation.

The species is thus well adapted to arid conditions. *Jatropha curcas* is also a suitable species for soil conservation areas and stabilization of shifting sand dunes. It can be successfully introduced on wastelands as a first step towards their rehabilitation. Because of the hardy nature of this species and the fact that it can be propagated easily by branch cuttings or direct seed sowing, it makes an ideal choice for the ecological and economic rehabilitation of wastelands in the tropical and sub-tropical regions of the world.

Economic importance of Jatropha

J. curcas is a promising species because of its useful and profitable by-products. The chemical composition of various parts of *J. curcas* plant, which has industrial applications is given in table 1 below. Jatropha oil has various uses and apart from its use as a biofuel, the oil has been used to produce soup, medicine and pesticides (Shanker and Dhyani, 2006). The utilization of various parts of *J. curcas* L. is reviewed here, to know the potentials for improving economic situation of various tropical and subtropical countries.

Erosion control as hedge plant and bio-fence

J. curcas has the advantage that not only is it capable of growing on marginal land, but it can also help to reclaim problematic lands and restore eroded areas. The cultivation of jatropha leads to the primary conservation benefits such as improved soil restoration and management. It can protect soil from erosion and plants from wind erosion (Haller, 1996).

Jatropha plant can serve as live fence for the protection of agricultural fields against damage by live stocks. The plant acts as cost effective bio-fence compared to wire fence. Jatropha is chosen for this purpose mainly because it can easily be propagated by cuttings, densely planted for this purpose, and because the said species is not browsed by cattle.

Medicinal use

Jatropha is known as the physic or purging nut for its use as purgative/laxative, and is widely known as medicinal for treatment of a variety of ailments. Preparations of all parts of the plant, including seeds, leaves and bark, fresh or as a decoction, are used in traditional medicine and veterinary purposes (Dalziel, 1955; Duke, 1985, 1988). The methanol extract of Jathropa leaves showed potent cardiovascular action in animals and might be a source of beta-blocker agent for humans. The sap flowing from the stem is used to control the bleeding of wounds. The latex of jatropha contains alkaloids including Jatrophine, jatropham and curcain with anti-cancerous properties (Van den Berg *et al.*, 1995; Thomas *et al.*, 2008). The roots are reported as an antidote for snake-bites. The anti-inflammatory activity of *J. curcas* L. root powder in paste form, was confirmed through the investigation conducted on albino mice by Mujumdar and Misar (2004). The oil has a strong purgative action and is widely used to treat skin diseases and to soothe pain from rheumatism (Heller, 1996; Marroquin *et al.*, 1997). The 36% linoleic acid (C18:2) content in jatropha kernel oil is of possible interest for skincare. Research is underway on the potential of this plant against HIV. Some of Medicinal uses of Jatropha are as follow.

Antioxidant activity

Hydro-alcoholic extract of the leaves, stem and root of *J. curcas* had showed significant antioxidant activity using in vitro antioxidant models like DPPH radical scavenging activity, nitric oxide radical scavenging activity, hydroxyl radical scavenging activity, reducing power method and hydrogen peroxide radical scavenging activity (Diwani *et al.*, 2009).

Hepatoprotective activity

Methanolic fraction of *J. curcas* L. showed hepatoprotective activity on aflatoxin B1 induced hepatic carcinoma in animals (Balaji *et al.*, 2009).

Wound healing activity

It was reported by Shetty *et al.*, (2006) that the herbal ointment of *J. curcas* leaves and barks accelerates the healing process by increasing the skin wound contraction, breaking strength, granulation tissue breaking strength, and dry granulation tissue weight and hydroxyproline levels in rats.

Antimetastatic and antiproliferative activity

Methanolic fraction of *J. curcas* L. was studied for its anti-metastatic activity using B16F10 melanoma cells in C57BL/6 mice. It was studied using MTT (3- [4, 5-dimethylthiazol–2-yl] -2,5-diphenyltetrazolium bromide; Thiazolyl blue) assay. The IC50 was found to be 24.8 µg /mL (Balaji *et al.*, 2009).

Antimicrobial activity

Methanolic, ethanolic and water extracts of stem bark from *J. curcas* L. revealed *in vitro* antimicrobial activity against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, and other microbes (Igbinosa *et al.*, 2009).

Antidiabetic activity

Antihyperglycemic effect of 50% ethanolic extract of leaves of *J. curcasL*.in was studied in normal and alloxan induced diabetic rats (Mishra *et al.*, 2010).

Anti-inflammatory activity

The methanolic extract of this plant exhibits anti-inflammatory activities in acute carrageenan-induced rat paw edema. Besides, it speculated activity against formalin-induced rat paw edema, cotton pellet-induced granular tissue formation, and turpentine-induced exudative changes in rats and mice (Mujumdar *et al.*, 2004).

Pregnancy terminating effect

Fetal resorption was observed with methanol, petroleum ether and dichloromethane extracts indicating the abortifacient properties of the fruit in rats. Besides, it might interrupt pregnancy occurred at an early stage after implantation (Goonasekera *et al.*, 1995).

Antiulcer activity

Methanolic extract of *J. curcas* L. in showed the antiulcer activity using aspirin induced gastric lesions in Wister rats (Kannappan *et al.*, 2008).

Anthelmintic activity

Aqueous extract of leaves has anthelmintic activity against nematodes (Ahirrao *et al.*, 2008).

Antifungal activities

The ethanolic extract of *J. curcas* L. seed cake exihited antifungal activities against several fungi, for example, *Pythium aphanidermatum, Fusarium oxysporum, Colletotrichum gloeosporioides, Curvularialunata, Lasiodiplodia theobromae*, *Colletotrichum capsici* and *F. semitectum*. The extract contained phorbol esters, which is responsible for showing antifungal activities (Donlaporn *et al.*, 2010).

Plant protectant

Extracts from all parts of the physic nut showed insecticidal properties on plants (Grainge and Ahmed, 1988; Consoli *et al.*, 1989; Jain and Trivedi, 1997; Meshram *et al.*, 1994). Most of the experiments done are still in experimental stage. The oil and aqueous extract from oil has potential as an insecticide. For instance, it has been used in the control of insect pests of cotton including cotton bollworm, and on pests of pulses, potato and corn (Kaushik and Kumar, 2004). The pesticidal action of the seed oil is also the subject of research of International Crops Research Institute for the Semi-Arid Tropics, (ICRISAT) in India.

Raw material for dye

The bark of *J. curcas* yields a dark blue dye which is reported to be used for coloring cloth, fishing nets and lines. The dye may be extracted from leaves and tender stems and concentrated to yellowish syrup or dried to blackish brown lumpy mass. The dye imparts to cotton different shades of tan and brown which are fairly fast. Further research in this field can open up great possibilities.

Firewood and input for charcoal production

The plants and fruit hulls could be used for firewood. Jatropha wood is a very light wood and is not popular as a fuel wood source because it burns too rapidly. Some have suggested converting press cake into charcoal. Seed cake can result to a very high-quality charcoal that has the potential to be used in high-value markets. But press cake is much more valuable to use as a fertilizer to ameliorate the impoverished soils in the developing countries with organic matter and increase crop production (Benge, 2006). No experiments are known so far. The scientist concluded that jatropha wood would not be of much value for either charcoal or firewood (Benge, 2006).

Input for biogas production

The seed cake can in principle be converted into biogas by digestion in biogas tanks as still it contains oil, together with other input materials, such as dung, leaves etc. The biogas can be used for cooking and lighting. The residue can still be used as organic fertilizer, as it retains all of its minerals and nutrients.

The use of seed cake as a single digestion input has been researched by Foidl and Eder (1997) but requires further investigation.

Human consumption

Jatropha can be toxic when consumed and many cases of poisoning with physic nut are reported in the literature (Siegel, 1893). However, a non-toxic variety of jatropha is reported to exist in some provenances of Mexico and Central America, said not to contain toxic Phorbol esters (Makkar *et al.,* 1998a, b).

This variety is used for human consumption after roasting the seeds/nuts (Delgado and Parado, 1989), and "the young leaves may be safely eaten, steamed or stewed." When grown from seeds, the plants are edible for the first 3 months, since the toxic material has not been developed yet. Levingston and Zamora (1983) report that jatropha seeds are edible once the embryo has been removed; nevertheless, on principal, consumption of seeds should be avoided. 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 (Becker, 1996; Makkar and Becker, 1997, 1999; Aregheore, 2003).

Oil for lighting and cooking

Although many researchers have described jatropha as a potential domestic fuel for cooking and lighting, with properties similar to kerosene, it cannot be used directly in conventional kerosene stoves or lamps. High ignition temperatures and viscosity (75.7 10-6 m 2 /s) as compared to kerosene (50-55°C, and 2.2x10-6 m 2 /s, respectively), mean that jatropha oil will not burn as well, and would clog up all the tubes and nozzles in a conventional stove or lamp. A low intensity lamp with a wick has been developed to circumvent these problems. The oil lamp and stove require a very short wick, so that the flame is very close to the oil surface. Further research is required to make available that special stove and lamp.

Oil as a biodiesel

Jatropha oil can be used as fuel in diesel engines directly and by blending it with methanol (Gubitz *et al.,* 1999). More recently, the clear oil expressed from the seed has been suggested for energetic purposes as a substitute for diesel. The oil obtained from the jatropha seed was used as diesel substitute during the World War II (Agarwal and Agarwal, 2007). The tests conducted during those days at Thailand were shown as a satisfactory engine performance (Takeda, 1982). Most importantly, it is significant to point out that the oil of *J. curcas* is a viable alternative to diesel fuel since it has desirable physico-chemical and performance characteristics as diesel. The obtained biodiesel from jatropha oil after transesterfication confirms the standard requirements of American and European countries (Azam *et al.,* 2005; Fairless, 2007; Tiwari *et al.,* 2007). Cars and trucks could be run with *J. curcas* oil without requiring much change in engine design. However, there are several points of view that differ considerably regarding jatropha‟s suitability as a substitute for petroleum products. The seed oil of jatropha may not be used directly in engines because of lower cetane number and higher viscosity at low temperatures as compared to conventional diesel. This may be due to the fact that, the diesel is a hydrocarbon with 8 to 10 carbon atoms per molecule whereas jatropoha seed oil has 16 to 18 carbon atoms per molecule. The transesterification process was adopted to convert jatropha seed oil into biodiesel. The Washington State University study optimistically concludes that while many vegetable oils are used to manufacture biodiesel, a given amount of land will produce much more oil from jatropha than from the common alternatives (soybeans, cotton seed, rapeseed, sunflower, groundnuts).

Oil for soap production

The local production of soap is one of the most economically attractive uses of jatropha oil. The glycerin by-product of the transesertification process can be used to make a high-quality soap, or it can be refined and sold at a range of prices, depending on its purity, to be used in an immense range of products, including cosmetics, toothpaste, embalming fluids, pipe joint cement, cough medicine, and tobacco (as a moistening agent). The soap has positive effects on the skin and is therefore marketed for medicinal purposes. Jatropha oil is used mainly in the manufacture of high-quality soap. According to the IPGI report, pressing of 12 kg of seeds yields 3 L of oil that is then transformed into soap, 28 pieces of soap of 170 g each, which is 4.76 kg. This takes 5 h of work (estimated). The total input is added to US $3.04. The soap can be sold for US $4.20, and the resulting 9 kg of press cake is well appreciated as organic fertilizer and can be sold for US $0.27; a total revenue of US $4.47 (Benge, 2006).

Seed cake use as manure

The byproduct of oil extraction from the seeds and kernels is called seed cake. Jatropha seed cake contains curcin, a highly toxic protein similar to ricin in Castor, making it unsuitable for animal feed. However, it does have potential as good organic manure (Staubmann *et al.*, 1997; Gubitz *et al.*, 1999), replacing chemical fertilizer since it has nitrogen content (Kumar and Sharma, 2008) similar to that of neem oil cake, castor bean, cow/chicken manure. The nitrogen content ranges from 3.2 to 3.8% (Juillet *et al.*, 1955; Moreira, 1979; Vohringer, 1987). Application showed phytotoxicity, expressed as reduced germination, when high rates of up to 5 tonnes ha^{-1} was used. The GTZ project in Mali carried out a fertilizer trial with pearl millet where the effects of manure (5 tonnes/ha), physic nut oil cake (5 tonnes/ha) and mineral fertilizer (100 kg ammonium phosphate and 50 kg urea/ha) on pearl millet were compared (Henning *et al.*, 1995). Pearl millet yields per hectare were maximum (1366 kg) in physic nut oil cake treatment. As the costs for mineral fertilizer were higher than those of the oil cake (Henning *et al.*, 1995), it is appreciated by the farmers and can be sold for 10 FCFA per kg (US $ 0.02/kg).

Seed cake use as animal feed

Press-cake derived from the non-toxic varieties of *J. curcas* may be used as animal feed. When processed as a cottage industry, the seed cake still contains approximately 11% oil, has 58 to 60% crude protein (53 to 55% true protein content), and the level of essential amino acids except lysine is higher than the FAO reference protein. Seed cake from Mexico and Central American non-toxic varieties may not be toxic. Non-toxic varieties are not grown in Asia and Africa.

Table.1 Chemical composition of different parts of *Jatropha curcas* plant

Various parts	Chemical composition with references
Root	β-sitosterol and its β-D-glucoside, marmesin, propacin, the curculathyranes A and B and the curcusones A–D, diterpenoids jatrophol and jatropholone A and B, the coumarin tomentin, the coumarino-lignan jatrophin as well as taraxerol [Naengchomnong *et al.*, 1986, 1994].
Stembark	β-Amyrin, β-sitosterol and taraxerol [Mitra *et al.*, 1970]
Leaves	Flavaonoids apigenin, vitexin, isovitexin, dimmer of atriterpene alcohol (C63H117O9) and two flavonoidal glycosides [Mitra *et al.*, 1970; Khafagy*et al.*, 1977; Hufford and Oguntimein, 1987]
Aerial parts	Organic acids (o and p-coumaric acid, p-OH-benzoic acid, protocatechuic acid, resorsilic acid, saponins and tannins, β-Amyrin, β-sitosterol and taraxerol [Hemalatha and Radhakrishnaiah, 1993]
Latex	Curcacycline A, a cyclic octapeptide, Curcain (a protease) [Van den Berg *et al.*, 1995; Nath and Dutta, 1991]
Seeds	Curcin, lectin, phorbolesters, esterases (JEA) and lipase (JEB) [Stirpe*et al.*, 1976; Adolf *et al.*, 1984; Makkar*et al.*, 1997; Staubmann*et al.*, 1999]
Oil cake and kernel	Phytates, saponins and trypsine inhibitor [Aregheore*et al.*, 1997; Makkar and Becker, 1997; Wink *et al.*, 1997]

Source: Kumar and Sharma (2008).

Summary and conclusion

Jatropha curcas L. or physic nut, is a bush or small tree (up to 6m height) and belongs to the euphorbia family. The genus Jatropha contains approximately 175 known species. The genus name Jatropha derives from the Greek jatrós (doctor), trophé (food), which implies medicinal uses. Curcas is the common name for physic nut in Malabar, India. The plant is planted as a hedge (living fence) by farmers all over the world, because it is not browsed by animals.

Jatropha curcas L., or physic nut, has thick glorious branchlets. The tree has a straight trunk and grey or reddish bark, masked by large white patches. It has green leaves with a length and width of 6 to 15 cm, with 5 to 7 shallow lobes. The leaves are arranged alternately.

Jatropha curcas originates from Central America. From the Caribbean, *Jatropha curcas* was probably distributed by Portuguese seafarers via the Cape Verde Islands and former Portuguese Guinea (now Guinea Bissau) to other countries in Africa and Asia. Today it is cultivated in almost all tropical and subtropical countries as protection hedges around gardens and fields, since it not browsed by cattle.

Possible Uses of the Jatropha Plant

- ❖ The Jatropha plant is used as a medicinal plant:
- ✓ The seeds against constipation;
- ✓ The sap for wound healing;
- ✓ The leaves as tea against malaria; etc.
- ❖ Jatropha is planted in the form of hedges around gardens or fields to protect the crops against roaming animals like cattle or goats;
- ❖ Jatropha hedges are planted to reduce erosion caused by water and/or wind;
- ❖ Jatropha is planted to demarcate the boundaries of fields and homesteads;

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