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Origin, Distribution, Ethnobotany and Pharmacology of *Jatropha curcas*

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ABSTRACT

Jatropha curcas L. (Euphorbiaceae) is a multipurpose perennial shrub/small tree, native to Mexico and Subtropical America, now grows naturally in most tropical areas of the world. It is an underutilized plant of multiple values. Various parts of the *J. curcas* are globally used for healthcare management of plants, human being and domesticated animals. Besides ethnomedicinal usages, this species have much other ethnobotanical, economic and ecological importance. Present review deals with origin and distribution, taxonomic description, ethnobotany, pharmacological activities, phytochemical properties and future prospective of this species.

Key words: Ethnobotany, ethnomedicine, Euphorbiaceae, *Jatropha curcas*

INTRODUCTION

The word 'Jatropha' is derived from Greek words 'Jatros' and 'trope' (food/nutrition) which implies medicinal uses. The genus *Jatropha* belongs to family Euphorbiaceae and subfamily Acalyphoideae and includes about 175 species. *Jatropha curcas* L. syn *Curcas purgans* Medik., *Ricinus americanus* Miller, *Castiglionia lobata* Ruiz. and Pavon. *Jatropha edulis* Cerv., *J. acerifolia* Salisb., *Ricinus jarak* Thunb., *Curcas adansoni* Endl., *Curcas indica* A. Rich. and *Curcas curcas* (L.) Britton and Millsp etc., are the most important species of the genus. Linnaeus classified the plant in 1753 and gave it the botanical name *Jatropha curcas* (Heller, 1996; Krishnan and Paramathma, 2009). It has 2n = 22 chromosomes (Soontornchainaksaeng and Jenjittikul, 2003; Jha *et al*., 2007; Carvalho *et al*., 2008). It is commonly known as physic nut, purging nut, barbados nut and nutmeg plant in English. Other vernacular names of *J. curcas* are pinhão manso, mundubi-assu (Brazil), pourghère (French), purgeernoot (Dutch), purgiernuss (German), purgeira, pinha˜o-manso (Portuguese), fagiola d'India (Italian), galamaluca (Mozambique), kadam (Nepal), yu-lu-tzu (Chinese), habel meluk (Arab), kananaeranda, parvataranda (Sanskrit), safed arand, bagbherenda, jangaliarandi, ratanjot (Hindi), mogalierenda, erandagachh, ranayerendi, jamalgota, nepalamu, peddanepalamu, kadalamannku, kattamankku, adaluharalu, karnocchi, kattavanaka, jahazigzba, bongalibhotorna, borbandong (various parts of India), sabudam (Thai), bagani (Ivory Coast) butuje funfun (Nigeria), makaen (Tanzania), piñoncillo (Mexico), tempate (Costa Rica) and piñon (Guatemala) (Anonymous, 1959; Heller, 1996; Carvalho *et al*., 2008; Brittaine and Lutaladio, 2010; Erinoso and Aworinde, 2012).

ORIGIN AND DISTRIBUTION

The origin of *J. curcas* remains controversial as it can be found over a wide range of countries in Central and South America. It is native to Central America but now grows naturally in most tropical areas of the world (Burkill, 1994; Heller, 1996; Openshaw, 2000; Fairless, 2007). Portuguese introduced *J. curcas* in Asia and Africa as an oil yielding plant. In India it occurs in wild, semi wild and cultivated state in almost all biogeographical zones from the coastal areas to the outer Himalayan ranges (Anonymous, 1959).

Morphological description: *Jatropha curcas* is a multipurpose perennial shrub/small tree of 3-6 m height. It may be evergreen or deciduous, depending on climate. It has a short tap root, robust laterals and many fine tertiary roots. The stem is woody, erect, cylindrical, solid and branched. Branches are stout, green and semi woody. Leaves are palmate and have 5-7 shallow lobes and are arranged in alternate with spiral phyllotaxis. Length and widths of leaves varies from 16-21 and 14-18 cm and are cauline and ramel, ex-stipulate, petiolate. Petioles are 12-19 cm long. Venation is multicostate, reticulate and divergent type (Anonymous, 1959; Singh, 1970; Heller, 1996; Raju and Ezradanam, 2002; Bhattacharya *et al*., 2005; Achten *et al*., 2008; Brittaine and Lutaladio, 2010).

Jatropha atropha curcas is monoecious and the terminal inflorescences contain unisexual greenish yellow 17-105 male and 2-19 female flowers in loose panicle of cymes. The ratio of male to female flowers ranges from 13:1 to 29:1. The inflorescence is composed by a main florescence and a distinct coflorescence. There are nodes on the upper pedicels of male (staminate) flowers and no node on the upper pedicels of female (pistillate) flowers. The flowers are tiny (about 7 mm), unisexual, regular, petals are oblong and light green in colour and sepals are quinquepartite. Androecium is absent in female flower, present in male flower with ten stamens. Stigma are six furcated, dorsifixed and introrse. Gynoecium is absent in male flowers but present in female flowers and is tricarpellary, syncarpous with trilocular and superior ovary. Flowers are pollinated by moths and bees. Fruits trilocullar, ellipsoidal, sudrupaceous. The exocarp remains fleshy until the seeds become mature, finally separating into three cocci. The fruit is 2.5-3.5 cm long to 2-2.5 cm wide. Seeds are black, oblong, 2.5-3 cm long and 1 cm thick, more or less spherical or ellipsoidal (Fig. 1). Seed weight (10 seed) ranges from 53-77 g which contains 13.06-42.41% oil content.

ETHNOBOTANY AND ECONOMIC BOTANY

Jatropha curcas is emerging as an interesting multipurpose species within academic, civil society and policy makers. The seed oil can be easily converted into liquid biofuel which meets the American and European standards (Azam *et al*., 2005; Fairless, 2007; Tiwari *et al*., 2007). Various parts of *J. curcas* can be used for healthcare management of plants, animals and human being (Table 1). Besides biofuels and healthcare management, *J. curcas* is also useful to control soil erosion and improved water infiltration, to reclaim wasteland, phytoremediation of various contaminated soils, livestock barrier and land demarcation or live fence around agricultural fields, fuel wood and support for vanilla, green manure, soil carbon sequestration and sustainable environmental development. Other economic products obtained from various parts of *J. curcas* are glycerol, soap, cosmetics, varnish, dye, molluscicide, pesticide, fertilizer, synthesis of silver nano-particles (Heller, 1996; Mangkoedihardjo and Surahmaida, 2008; Bar *et al*., 2009; Jamil *et al*., 2009; Sharma and Pandey, 2009; Agamuthu *et al*., 2010; Brittaine and

Fig. 1(a-h): Morphology of *Jatropha curcas* L., (a) Plant having leaves and fruits, (b) Stem, (c) Leaves, (d) Flower, (e) Immature fruits, (f) Mature fruits, (g) Seeds and (h) Crude seed oil

Lutaladio, 2010; Pandey *et al*., 2012; Warra, 2012). Seeds are toxic for human (Kulkarni *et al*., 2005) and animal and are used as ordeal poisons for internal use in Africa (De Smet, 1998). Seed cake may also be used for human consumption after treatment (Schuh and Schuh, 2012).

Table 1: Traditional medicinal uses of various parts of *Jatropha curcas* L.

Plant part used	Medicinal uses	References
Leaves	Ulcers, septic gums, cuts, wounds, burns, itched and blistered skin, ulcer, purgative, pneumonia, rubefacient, lactagogue, mastitis, koilonychia, insecticidal, piles, diarrhoea, urinary infection, intestinal parasites, Stroke, thrombosis, toothache, pains, healing, hemostatic, malaria, hypertension	Anonymous (1959), Ambasta (1986), Longuefosse and Nossin (1996), Lans *et al*. (2001), Saikia *et al*. (2006), Lans (2007), Namsa *et al*. (2009), Brittaine and Lutaladio (2010), Upadhyay *et al*. (2010), Cartaxo *et al*. (2010), Tangjang *et al*. (2011), Offiah *et al*. (2011), Moshi *et al*. (2012), Pragada and Rao (2012) and Srivastava *et al*. (2012)
Stem and stem bark	Toothache, gum problems, inflammation, pyorrhoea, Infectious diseases, tympani, sexually transmitted diseases, urinary infection, diarrhoea, indigestion, rheumatism, leprosy, fever, jaundice, gonorrhea, pneumonia	Namsa *et al*. (2009), Brittaine and Lutaladio (2010), Upadhyay *et al*. (2010), Offiah *et al*. (2011), Deshmukh *et al*. (2011), Umapriya *et al*. (2011), Srivastava *et al*. (2012) and Pragada and Rao (2012)
Latex/plant sap/extract	Stop bleeding, reduced the blood clotting time, snake-bites, infected sores, treating newborns umbilical cords, coughs, mouth and throat sores, stroke, thrombosis, toothache, stomach-ache, pains in general, healing, hemostatic, HIV-AIDS, tumor, wound healing, allergies, burns, cuts and wounds, inflammation, leprosy and other dermatological disorders	Anonymous (1959), Ambasta (1986), Lans *et al*. (2001), Manandhar (2002), Baral and Kurmi (2006), Kunwar *et al*. (2009), Idu *et al*. (2009), Cartaxo *et al*. (2010), Chowdhury and Koike (2010), Upadhyay *et al*. (2010), Nath *et al*. (2011) and Umapriya *et al*. (2011)
Root/root bark	Inflammation, external parasite, gout, rheumatism, diarrhoea, dysentery, gonorrhea, east coast fever 'makebe'	Ambasta (1986), Tabuti *et al*. (2003), Baral and Kurmi (2006), Brittaine and Lutaladio (2010), Deshmukh *et al*. (2011), Wagh *et al*. (2011) and Nath *et al*. (2011)
Flower	Diarrhoea	Offiah *et al*. (2011)
Fruit	Stroke, toothache, control of reproduction, inflammation, numbness after bug sting, to clean mother's and baby's blood during the pregnancy	Watt and Breyer-Brandwijk (1962) and Grade *et al*. (2009)
Seeds/ seed oil	Eczema, skin diseases, rheumatic pain, purgative, gout, arthritis and jaundice, wound-healing, fractures, burns, boils, malaria, constipation, gonorrhea, syphilis	Anonymous (1959), Ambasta (1986), Luseba and Van der Merwe (2006), McGaw and Eloff (2008), Kunwar *et al*. (2009), Brittaine and Lutaladio (2010), Mesfin *et al*. (2012) and Erinoso and Aworinde (2012)

PHARMACOLOGICAL ACTIVITIES

Anti-bacterial activity: Acetone, chloroform, ethanol and methanol extracts of *J. curcas* root bark has been reported to inhibit the growth of both gram-positive (*Staphylococcus aureus*) and gram negative bacteria like *Klebsiella pneumonia*, *Pseudomonas aeruginosa*, *Salmonella typhimurium* and *Escherichia coli* (Naqvi *et al*., 1991; Muanza *et al*., 1994; Tona *et al*., 1999; Sundari *et al*., 2011).

Anti-fungal activity: Various plant parts of *J. curcas* have antifungal activity against *Aspergillus fumigatus*, *A. flavus*, *A. niger*, *Bacillus subtillis*, *Phymatotrichopsis omnivora*, *Candida albicans* etc. which are responsible for many diseases in human being and plants (Naqvi *et al*., 1991; Muanza *et al*., 1994; Kubmarawa *et al*., 2007; Hu *et al*., 2011; Sundari *et al*., 2011).

Antiviral activity: The water extract of the branches of *J. curcas* strongly inhibit the HIV-induced cytopathic effects with low cytotoxicity (Matsuse *et al*., 1999). Latex of *J. curcas* possesses inhibitory property against *Water melon mosaic virus* (Tewari and Shukla, 1982).

Anti-inflammatory activity: Topical application of *J. curcas* root powder in paste form in mice and rats has been reported to possess anti-inflammatory activity by Mujumdar and Misar (2004).

Anti-oxidant activity: Root bark extract of *J. curcas* were capable of scavenging hydroxyl in a concentration dependent manner and have a stronger hydroxyl scavenging activity of compared with ascorbic acid (Sundari *et al*., 2011).

Coagulant and anticoagulant activities: Latex is a blood coagulant whereas dilute latex is anticoagulant. Curcin from seed produces deleterious effects to the blood (Osoniyi and Onajobi, 2003).

Anti-diarrhoeal activity: The petroleum ether and methanol extract of *J. curcas* roots shows anti-diarrhoeal activity in various species of albino mice (Mujumdar *et al*., 2000).

Pregnancy terminating effect: Pregnancy terminating effect of methanol, petroleum ether and dichloromethane extracts extract of *J. curcas* fruits in rats have been scientific reported by Goonasekera *et al*. (1995).

Wound healing activity: Wound healing activities of stem bark of *J. curcas* has been reported in literature (Villegas *et al*., 1997; Shetty *et al*., 2006; Igbinosa *et al*., 2009). Sachdeva *et al*. (2011) had scientifically evaluated wound healing potential of white soft paraffin base ointment containing 5 and 10% (w/w) extract of stem bark of *J. curcas* using incision and excision wound model in albino rats.

Insecticidal, larvicidal and anthelmintic activity: Various plant parts of *J. curcas* have been reported to possess insecticidal and larvicidal and anthelmintic activity. Insect pests of stored grains (*Sitophilus zeamais* and *Rhyzorpertha dominica*) are susceptible to seeds and pericarps of *J. curcas* (Silva *et al*., 2012). Ethanol extract of leaves of *J. curcas* may be as useful for developing a safe and ecofriendly therapeutic agent to combat the problems of tick *Rhipicephalus* (*Boophilus*) *annulatus* and tick-borne diseases (Juliet *et al*., 2012). *Jatropha curcas* is a potential source of herbal mosquito control agent. Larvicidal activities methanol extract of leaves, crude protein extract and purified toxin, Jc-SCRIP, from the seed coat of *J. curcas* has the larvicidal potential against *Aedes aegypti*, *Anopheles arabiensis*, *Aedes aegypti* and *Culex quinquefasciatus* (Karmegam *et al*., 1997; Rahuman *et al*., 2008; Sakthivadivel and Daniel, 2008; Aina *et al*., 2009; Cantrell *et al*., 2011; Tomass *et al*., 2011; Kovendan *et al*., 2011; Nuchsuk *et al*., 2012). Aqueous extract of leaves of *J. curcas* possesses anthelmintic activity against *Pheritima poshtuma* (Ahirrao *et al*., 2008, 2011).

Phytochemicals: The leaf, bark and latex of *Jatropha* contains alkaloids such as jatrophine, jatropham, curcacycline A, curcain, tannins, glycosides, flavonoids and sapogenins with anti-cancerous properties (Van den Berg *et al*., 1995; Thomas *et al*., 2008; Debnath and Bisen, 2008). The seeds of *J. curcas* contains some toxic compounds such a protein (curcin) and

phorbol-esters diterpenoids (King *et al*., 2009). The diterpenes isolated from *Jatropha* species belongs to rhamnofolane, daphnane, lathyrane, tigliane, dinorditerpene, deoxy preussomerin and pimarane skeletal structures and the majority of the diterpenes exhibited cytotoxic, antitumor and antimicrobial activities *in vitro*. Jatrophone, spruceanol and jatrophatrione exhibited antitumor properties against P338 lymphocytic leukaemia and japodagrol against KB carcinoma cells. Curcusone exhibited anti-invasive effects against cholangiocarcinoma cells. The phorbol esters (Jatropha factor C1-C6) and jatropherol exhibited insect deterrent/cytotoxic properties. Jatrophalactam, faveline derivatives, multifolone, curcusone, jatrophone derivatives etc. have shown *in vitro* cytotoxic activity. Japodagrin, jatrogrossidione derivatives and jatropholone derivatives exhibited antimicrobial activities. Jatropha diterpenoids having a wide spectrum of bioactivity could form lead compounds or could be used as templates for the synthesis of new compounds with better biological activity for utilization in the pharmaceutical industries (Devappa *et al*., 2011). Three deoxypreussomerins, palmarumycins CP1, JC1 and JC2, have been isolated from the stems of *J. curcas* (Ravindranath *et al*., 2004) which possess a wide range of biological properties including antibacterial, antifungal, herbicidal, antibiotic and antitumor activities (Wipf *et al*., 2001). *Jatropha curcas* seed oil chemically consists of triacylglycerol with linear fatty acid chain. Palmitic acid, stearic acid, oleic acid and linoleic acid, lauric acid, meristic acid, arachidic acid, arachidonic acid and behenic acid are some important fatty acids present in *J. curcas* seed oil (Adebowale and Adedire, 2006; De Oliveira *et al*., 2009). Li *et al*. (2010) identified a new chemical compound jatrophasin A (3,4,4',5'-tetrahydroxyl-3'-methoxyl-bisepoxylignan) with strong anti-oxidative activity from the seeds of *J. curcas*.

CONCLUSION

Large scale seed production of *J. curcas* remains the single most important issue that will ultimately decide the success of this crop at commercial level. High seed productivity and oil content are desired for commercial utilization of this crop for biofuel production. The challenges of developing viable market for *J. curcas* are as follows:

- Besides biofuel, research on medicinal, plant protecting and other economic potential of various plant parts of *J. curcas* for development of new pharmaceuticals and plant protectants of herbal origin
- Economic analysis of the biogas production potential of husk and seed cake
- Economic analysis of fertilizer value of the seed cake
- Identification of sufficient quantity and quality of available land for large scale commercial cultivation of *J. curcas* which do not compete with food production
- Identification of suitable accessions of *J. curcas* for various types of degraded lands and agro climatic zones
- Identification of suitable practice of packages (irrigation, nutrient management requirement and optimum use of organic, chemical and/or biofertilizer etc.) for cultivation of *J. curcas* in various types of degraded lands and agro climatic zones
- Practice of apiculture in *J. curcas* field to promote pollination resulting good seed yield
- Though influence of pruning on growth and dry mass partitioning has been analyzed by Rajaona *et al*. (2011) but its effect on seed yields has yet to be analyzed
- Intercropping of *J. curcas* with non edible crops like essential oils to increase income per unit land area

- Building agencies to facilitate trade of seed between smallholder farmers and industries using the seed for oil extraction and processing for production of value added products including biodiesel
- Increasing investment in *Jatropha* research projects for development of pharmaceutical and plant protectants (insecticide and pesticide for crops and stored grains) along with projects ensuring commercial seed production on various types of waste land and efficient seed oil extraction methods
- Economic analysis of use of seed oil for agricultural instruments (tube well, tractors etc.), lighting and soap production in rural areas
- Socioeconomic studies on how *J. curcas* can aid development in rural areas

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