A REVIEW ON CHEMICAL AND MEDICOBIOLOGICAL APPLICATIONS OF JATROPHA CURCAS

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ABSTRACT

Jatropha curcas, a multipurpose, drought resistant, perennial plant belonging to Euphorbiaceae family is gaining lot of importance for the production of biodiesel. It is a tropical plant that can be grown in low to high rainfall areas either in the farms as a commercial crop or on the boundaries as a hedge to protect fields from grazing animals and to prevent erosion. Before exploiting any plant for industrial application, it is imperative to have complete information about its biology, chemistry, and all other applications so that the potential of plant could be utilized maximally. The taxonomy, botanical description of the plant, its distribution and ecological requirement are discussed in this paper. The detailed information about the presence of various chemicals including toxins in different parts of the plant is summarized. The possibilities of potential of plant for various pharmacological activities have been summarized. The information about the toxins and detoxification methods is collected and discussed. Overall, this paper gives an overview on covering the biology, chemistry, toxicity of seeds and detoxification and various industrial uses.

KEYWORDS: Jatropha curcas, Euphorbiaceae, biodiesel

INTRODUCTION

The genus Jatropha belongs to tribe Joannesiae in the Euphorbiaceae family and contains approximately 170 known species. Jatropha (figure1), a drought-resistant shrub or tree, is widely distributed in the wild or semi-cultivated areas in Central and South America, Africa, India and South East Asia. It was the first to name the physic nut Jatropha L. in “Species Plantarum” and this is still valid today. The genus name Jatropha derives from the Greek word jat’ros (doctor) and trophi (food), which implies medicinal uses. Jatropha is common name for the physic nut in Malabar, India. The physic nut, by definition, is a small tree or large shrub, which can reach a height of three to five meters, but under favourable conditions it can attain a height of 8 or 10m. The plant can be used to prevent soil erosion, to reclaim land, grown as a live fence, especially to exclude farm animals and also planted as a commercial crop. Various parts of the plant are of medicinal value, its bark contains tannin, the flowers attract bees and thus the plant has a honey production potential. Its wood and fruit can be used for numerous purposes including fuel. It is easy to establish and grows relatively quickly. The purpose of this review is to provide information about current development in the field of Jatropha research.

Botanical description of Jatropha curcas

Jatropha curcas L., or physic nut, has thick glorious branchlets. Its botanical description is given in figure 2. 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. Dormancy is induced by fluctuations in rainfall and temperature/light. But not all trees respond simultaneously. In a hedge you may have branches without leaves and next to them, branches full of green leaves. The branches contain whitish latex, which causes brown stains, which are very difficult to remove. Normally, five roots are formed from seeds: one tap root and 4 lateral roots. Plants from cuttings develop only lateral roots. Inflorescences are formed terminally on branches. The plant is monoecious and flowers are unisexual. Pollination is by insects. After pollination, a trilocular ellipsoidal fruit is formed. The exocarp remains fleshy until the seeds are mature. The seeds are black and in the average 18 mm long (11 – 30) and 10 mm wide ripe Jatropha fruits (7 – 11). The life-span of the Jatropha curcas plant is more than 50 years.

Roots

Normally, five roots are formed from seedlings, one central and four peripheral. A tap root is not usually formed by vegetatively propagated plants.
Leaves Leaves five to seven lobed, hypostomatic and stomata are of paracytic (Rubiaceous) type. These are large green to pale green colours.

Flowers The trees are deciduous, flowering occurs during the wet season and in permanently humid regions, flowering occurs throughout the year. The inflorescence is axillary paniculate polychasial cymes. Male and female flowers are produced on the same inflorescence, averaging 20 male flowers to each female flower or 10 male flowers to each female flower. The plant is monoecious and flowers are unisexual; occasionally hermaphrodite flowers occur. A flower is formed terminally, individually, with female flowers (tricarpellar, syncarpous with trilocular ovary) usually slightly larger and occurs in the hot seasons. The petiole length ranges between 6-23 mm. In conditions where continuous growth occurs, an unbalance of pistillate or stamine flower production results in a higher number of female flowers. Ten stamens are arranged in two distinct whorls of five each in a single column in the androecium, and in close proximity to each other. In the gynoecium, the three slender styles are connate to about two-thirds of their length, dilating to massive bifurcate stigma. The rare hermaphrodite flowers can be selfpollinating.

Stem The branches contain latex.

Fruits Each inflorescence yields a bunch of approximately 10 or more ovoid fruits. Fruits are produced in winter, or there may be several crops during the year if soil moisture is good and temperatures are sufficiently high. Three, bivalve coccid is formed after the seeds mature and the fleshy exocarp dries.

Seed The seeds are mature when the capsule changes from green to yellow about 3–4 months after flowering. The seeds are black and the seed weight per 1000 is about 727 g, there are 1375 seeds/kg in the average. The physic nut is a diploid species with 2n = 22 chromosomes.

DISTRIBUTION

Jatropha curcas L. 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. Jatropha grows almost anywhere except waterlogged lands, even on gravelly, sandy and saline soils. It will grow under a wide range of rainfall regimes from 250 to over 1200 mm per annum. Today it is cultivated in almost all tropical and subtropical countries.

ECOLOGY

Jatropha curcas L. is not a weed. It is not self propagating. It has to be planted. It grows well with more than 600 mm of rainfall per year, and it withstands long drought periods. With less than 600 mm it cannot grow except in special conditions like on Cape Verde Islands, where the rainfall is only 250 mm, but the humidity of the air is very high (rain harvesting). It cannot stand frost. It survives a very light frost, but it loses all leaves. The production of seeds will probably go down sharply.

USES OF JATROPHA CURCAS

India is by far the country with the largest potential for Jatropha, the most advanced discussion, high-level decisions, biggest number and types of institutions involved and the broadest variety of experiences in the field of Jatropha, including most related issues and questions. India has the largest rural and agricultural population, severe problems with soil degradation, erosion and deforestation, and a scaring decrease of water supply and depletion of aquifers. At the same time salaries, farm incomes and food supplies are low, farm labour is mostly available; there is a need for an integrated farm management and an alarming overuse of resources. Rural energy and electricity supply is insufficient and further depleting resources, mainly through forest and dung use. Petroil-oil sources are said to deplete in 20 years at present consumption rates, with 70% being imported at present. India has almost one third of agricultural lands degraded and has between 50 and 150 Mio ha of not used, underused or degraded land, for reasons of and as a result of overuse, drought, erosion and deforestation.

There is an impressive history and diversity of farming systems, agro-industries and organisational structures. As well, there is an outstanding biodiversity (45.000 wild species of plant, 77.000 wild species of animals recorded) and its use for a variety of purposes in different regions of the country, even though still reducing at a rapid rate. At the same time, India has decided upon internationally by far the most impressive and comprehensive National Program on Jatropha promotion; this in terms of level of political involvement, the broad and integrated objectives meant to be reached and the level of funds being made available. Jatropha projects are documented to be carried out since 1991 with disappointing results. However, there is now more experience, better expertise about the strengths and weaknesses and success factors in India available, even though not yet well compiled. As well, Jatropha efforts
have a much better Government backing now than ten years ago. 

*Jatropha curcas* L. is planted in the form of hedges around gardens or fields to protect the crops against roaming animals like cattle or goats and to reduce erosion caused by water and/or wind. Uses of different parts of jatropha curcas plant are given in table 1. The superior quality oil can be extracted from the seeds. The oil can be used as a mixed fuel for diesel/gasoline engines. The *Jatropha curcas* L. plant is used as a medicinal plant such as seeds against constipation; sap for wound healing; leaves as tea against malaria etc. In Comore islands, in Papua New Guinea and in Uganda *Jatropha curcas* L. plants are used as a support plant for vanilla plants; as a source of shade for coffee plants in Cuba. 

### PHYTOCHEMISTRY OF *JATROPHA CURCAS*

Chemical composition of various parts of *Jatropha curcas* plant is given in table 2. Three deoxypreussomerins, palmarumycins CP1, JC1, JC2 were isolated from stem of *Jatropha curcas* L. in which JC1 and JC2 showed the antibacterial activity. *Jatropha* oil contains approximately 24.60% of crude protein, 47.25% of crude fat, and 5.54% of moisture contents. Numerous sources are available on the fatty acid composition of physic nut oil originating from different countries. The oil fraction of *Jatropha* contains saturated fatty acids mainly palmitic acid (16:0) with 14.1% and stearic acid (18:0) with 6.7%. Unsaturated fatty acids consisted of oleic acid (18:1) with 47.0%, and linoleic acid (18:2) with 31.6%. The oil with high percentage of monounsaturated oleic and polyunsaturated inoleic acid has a semi-drying property (partially hardens when the oil is exposed to air). This semi-drying oil could be an efficient substitute for diesel fuel. Treatment of plants with growth regulators significantly influenced the production of hydrocarbons. Among the treatments, ethephon and morphactin induced the maximum production of hydrocarbon with 5.0 and 5.4% respectively.

### PHARMACOLOGICAL POTENTIAL OF PLANT*

The oil has a strong purgative action and is also widely used for skin diseases and to soothe rheumatic pain. A decoction of leaves is used against cough and as an antiseptic after birth. In a number of species of the genus *Jatropha*, used in folk medicine in tropical areas, the active principle is the macrocyclic diterpenoid jatrophone, which co-occurs with the inactive diterpenoids jatropholone A and B. Callus and suspension cultures of *Jatropha* cathartica, *J*. cinerea, *J*. curcas, *J*. dioica, *J*. elliptica, *J*. multifida, *J*. podagrica and *J*. mollissima were established, but most of the cell lines tested accumulated no, or only small quantities of jatrophone. The maximum jatrophone accumulation (3 μg·g⁻¹ dry weight) was obtained with callus and suspension cultures derived from *J*. curcas and *J*. elliptica. Root-organ cultures of *J*. elliptica formed following incubation of suspension cells in the presence of 3-indolebutyric acid (5 mg·L⁻¹). The maximum accumulation of jatrophone and the jatropholones in newly initiated roots grown in vitro was 329 and 458 μg·g⁻¹ dry weight, respectively. The effects on diterpenoid accumulation by root-organs of alteration of environmental parameters, and of the addition of chitosan, Benomyl and Al[3+] to the growth medium were investigated. The yield of jatrophone was significantly increased in the presence of 0.07-0.7 mM/L Al[3+], and the product profile was altered concomitantly.

### Antioxidant activity

Hydro-alcoholic extract of the leaves, stem and root of *Jatropha curcas* L 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.

### Hepatoprotective activity

Methanolic fraction of *Jatropha curcas* L. showed hepatoprotective activity on aflatoxin b1 induced hepatic carcinoma in animals.

### Wound healing activity

Herbal ointment containing the leaf and bark extract of *Jatropha curcas* L. in wistar albino rats accelerates the healing process by increasing the skin breaking strength, granulation tissue breaking strength, wound contraction, dry granulation tissue weight and hydroxyproline levels.

### Antimetastatic and Antiproliferative activity

Methanolic fraction of *Jatropha 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 and the IC50 was found to be 24.8 μg/ml.

### Antimicrobial activity

Antidiabetic activity
Antihyperglycemic effect of 50% ethanolic extract of leaves of *Jatropha curcas* L. was studied in normal and alloxan induced diabetic rats.

Ant-inflammatory activity
The methanol extract exhibited systemic and significant anti-inflammatory activity in acute carrageenan-induced rat paw edema. It also showed activity against formalin-induced rat paw edema, as well as, turpentine-induced exudative changes and cotton pellet-induced granular tissue formation in mice and rats.

Pregnancy terminating effect
Foetal resorption was observed with methanol, petroleum ether and dichloromethane extracts indicating the abortifacient properties of the fruit in rats. It suggested that the interruption of pregnancy occurred at an early stage after implantation.

Antinulear activity
Methanolic extract of *Jatropha curcas* L. showed the antinulear activity using aspirin induced gastric lesions in wister rats.

Anthelmintic activity
Aqueous extract of leaves have anthelmintic activity against Phereetima Poshtuma.

Antifungal Activities
The ethanolic extract of *Jatropha curcas* L. seed cake showed antifungal activities against important fungal phytopathogens: Fusarium oxysporum, Pythium aphanidermatum, Lasiodiplodia theobromae, Curvularia lunata, Fusarium semitectum, Colletotrichum capsici, and Colletotrichum gloeosporioides. The extract contained phorbol esters mainly responsible for antifungal activities.

Toxicity of seed oil
Seed oil is used against Callosobruchus maculates insects, parasites, Dinarnusbaralis.

Nickel toxicity
Nickel toxicity induced in *Jatropha curcas* L. has shown a correlation between responses of antioxidant enzymes as well as PAL activities and nickel concentration in J. curcas cotyledons. The low nickel conc. and higher superoxide dismutase (SOD), peroxidase (POD), catalase (CAT) and phenylalanine ammonia lyase (PAL) activities suggested the tolerance capacity of plant which protects it from oxidative damage.

Allelopathic effect of *Jatropha curcas* on marigold (Tagetes erecta L.)
Leaf leachates of *Jatropha curcas* L. in the soil significantly inhibited the shoot and root length of marigold compared to unamended soils. The leaf leachates increased the RMP and proline content in the roots of marigold seedlings.

CONCLUSION AND FUTURE PROSPECTS
The Jatropha industry is at a very early stage of development. There are areas in the world where interest in the plant is especially strong, such as Central America where it was originated, and Mali, where it is widely grown as a live hedge and a lot of research has been done on biodiesel derived from it. Jatropha is one among many oil seeds that can be used to produce biodiesel, soap and fertilizer. Knowledge of physical properties and their dependence on moisture content of Jatropha seed is essential to improve the design of equipment for harvesting, processing and storage of seeds. Currently, growers are unable to achieve the optimum economic benefits from the plant, especially for its various uses. The markets of different products from this plant have not been properly explored or quantified. It is examine the potential role that Jatropha can play in meeting some of the needs for energy services for rural communities and also creating avenues for greater employment.

REFERENCES


**Table 1:** Uses of different parts of *J. curcas* in medicines

<table>
<thead>
<tr>
<th>Plant part used</th>
<th>Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seeds</td>
<td>To treat arthritis, gout, jaundice &amp; as contraceptives</td>
</tr>
<tr>
<td>Nuts</td>
<td>Contraceptive</td>
</tr>
<tr>
<td>Bark</td>
<td>As fish poison</td>
</tr>
<tr>
<td>Latex</td>
<td>To inhibit watermelon mosaic virus</td>
</tr>
<tr>
<td>Shrub</td>
<td>Hepatoprotective and antibiosis</td>
</tr>
<tr>
<td>Tender twig/stem</td>
<td>Toothache, gum inflammation, gum bleeding, pyorrhoea</td>
</tr>
<tr>
<td>Plant sap</td>
<td>Dermatomucosal diseases</td>
</tr>
<tr>
<td>Plant extract</td>
<td>Allergies, burns, cuts and wounds, inflammation, leprosy, leucoderma, scabies and small pox</td>
</tr>
<tr>
<td>Water extract of branches</td>
<td>HIV, tumor</td>
</tr>
<tr>
<td>Plant extract</td>
<td>Wound healing</td>
</tr>
</tbody>
</table>

**Table 2:** Chemical composition of different parts of *Jatropha curcas*

<table>
<thead>
<tr>
<th>Various parts</th>
<th>Chemical composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerial parts</td>
<td>Organic acids (o and p-coumaric acid, p-OH-benzoic acid, protocatechuic acid, resorcial acid), saponins and tannins</td>
</tr>
<tr>
<td>Stembark</td>
<td>Amyrin, sitosterol and taraxerol</td>
</tr>
<tr>
<td>Leaves</td>
<td>Cyclic triterpenes stigmasther, stigmast-5-en-3, 7 diol, stigmast-5-en-3,7, diol, cholest-5-en-3,7, diol, campesterol, sitosterol, 7-keto-sitosterol as well as the d-glucoside of sitosterol. Flavonoids apigenin, vitexin, isovitexin. Leaves also contain the dimer of a triterpene alcohol (C30H42O6) and two flavonoidal glycosides</td>
</tr>
<tr>
<td>Latex</td>
<td>Curcycycline A, a cyclic octapeptide Curcin (a protease)</td>
</tr>
<tr>
<td>Seeds</td>
<td>Curcin, a lectin Phorbolesters Esterase (JEA) and Lipase (JE2)</td>
</tr>
<tr>
<td>Kernal and press cake</td>
<td>Phytates, saponins and a trypsin inhibitor</td>
</tr>
<tr>
<td>Roots</td>
<td>Sitosterol and its d-glucoside, marmesin, propacin, the curlyalustyranes A and B and the curcuaseones A-D. diterpoids jatrophol and jatrophonol A and B, the coumarin tomentin, the coumarino-lignan jatroph in as well as taraxerol</td>
</tr>
</tbody>
</table>
Figure 1: *Jatropha curcas* plant

Figure 2: Important parts of the *Jatropha curcas*: a- flowering branch; b- bark; c- leaf veinature; d- pistillate flower; e- staminate flower; f- cross cut of immature fruit; g- fruits; h- longitudinal cut of fruits