Jatropha Curcas: A Boon of Energy

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Abstract

Biofuel originally comes from the sun captured through photosynthesis by the plants used as feedstock for biofuel production and stored in the plants' cells. Various plants and plant derived materials are used for biofuel manufacturing. One of the plants that have been considered among the most promising for production of biofuel is *Jatropha curcas*. These and many other organic materials are more sustainable than petroleum, meaning they can be regrown and remain productive with less negative impact on our ecosystem. Present paper deals with general information and other uses about this miraculous, multipurpose, commercially significant large shrub. It is one of the commonly occurring species in India and locally known as Ratanjyot or Jangli erandi. The harvested Jatropha seeds are used for production of Jatropha oil and biodiesel. The Jatropha oil can be used directly as a liquid fuel in older diesel motors, in generators and pumps running at a constant speed or in newer engines with small modifications in the fuel system. The Jatropha oil can also be mixed with fossil diesel before use in the engine, which combines the properties of the fossil fuel with the lower environmental impact of the vegetable oil (Achten, 2008; Siddharth, 2009).

Keywords: *Jatropha curcas*, Jatropha oil, Biofuel, Biodiesel.

Introduction

As civilization is growing, transport becomes essential part of life. The biggest problem is the growing population & depletion of fossil fuel. In India, the energy demand is increasing at a rate of 6.5 per cent per annum (Dwivedi *et al.*, 2011). The crude oil demand of country is met by import of about 70 per cent. The resources of petroleum fuel are dwindling day by day and increasing demand of fuels necessitates the search for alternative of oil as energy source. Biodiesel is an alternative fuel for diesel engine. The esters of vegetable oils and animal fats are known collectively as biodiesel.

Biofuels offer a number of benefits over fossil fuels. They can extend fuel supplies and reduce dependency on imported fossil fuels. Biofuels are considered as a renewable energy source because they are made from crops that can be replanted. Fossil fuels, on the other hand, are considered non-renewable because they exist in limited quantities. Burning biofuels releases carbon dioxide into the atmosphere, much like fossil fuels do. However, the plants from which biofuels are made also take carbon dioxide out of the atmosphere during photosynthesis. As a result, biofuels do not contribute to greenhouse gases, unlike fossil fuels. Biofuels are also biodegradable and safer to handle than fossil fuels, making spills less hazardous and easier to clean up.

One of the crops that have been considered among the most promising for production of biodiesel is *Jatropha curcas* because it does not compete directly with food production since the whole plant is toxic and hence non-edible. More importantly, the potential of Jatropha to grow on degraded soil and its resistance to drought and pests enable cultivation on land that is not suitable for food production (Biswas, 2009). The characteristics of *Jatropha curcas* have raised expectations for biodiesel production and a large-scale government programme was launched in 2003 for promotion and implementation of biodiesel production from Jatropha (Planning Commission, 2003).

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JATROPHA CURCAS

Jatropha curcas is a renewable, non-edible, oleaginous plant. It belongs to family *Euphorbiaceae* and also known as Physic nut, Barbados nut, etc., locally it is known as Ratanjyot or Jangli erandi.

Native

Jatropha curcus is formerly a native of South America but nowadays, it thrives all through Africa, South-east Asia and India (Makkar *et al.*, 2009). *Jatropha curcus* is being cultivated in 32 countries around the world, including India, Mali, Mexico, Sri Lanka, Nepal, Cambodia, South Africa, Tunisia, China, Bangladesh, Egypt, and the United States.

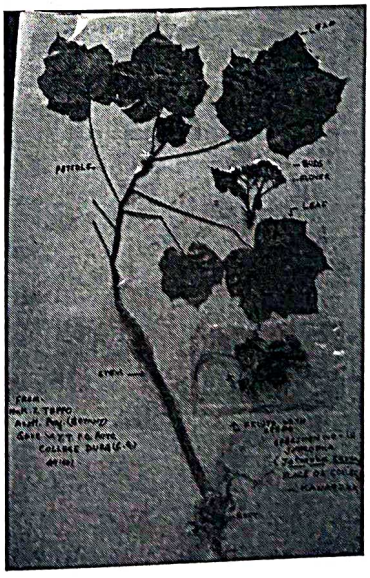
Ecology

According to current knowledge, *Jatropha curcus* is an easily established, drought-resistant plant (Namuli *et al.*, 2011) which grows relatively quickly. It is therefore well-adapted to semi-arid and arid conditions. Its characteristics make it suitable not only for cultivation for oil production but also for use as a live fence and for reclamation of eroded land (Kheira, 2009). Under stress such as low sun radiation, drought and cold weather, *Jatropha curcus* can retrieve and store the nutrients from its leaves, which then turn yellow and are shed. The stem remains photosynthetically active and in this state the plant can survive without rain for over a year (Fact Foundation, 2009a).

Regarding preferred soil type, *Jatropha curcus* is said to be adaptable and can grow almost everywhere except on waterlogged land. It grows on gravelly, sandy and saline soils and can be found in the poorest stony soil and even in the crevices of rocks (Kumar and Sharma, 2008).

Biology of *Jatropha Curcas*

It is a large glabrous shrub or small tree which can reach a height of three to five metres and rarely can attain a height of 10 metre under favourable conditions (Kumar and Sharma, 2008). It has a life expectancy of up to 50 years, maturing after four to five years. *Jatropha* is a plant of deciduous type and sheds its leaves during dry season and also under stressful conditions (Fact Foundation, 2009a). Leaves are green and brilliant, mostly from 7 to 16 cm long and around the same width. Stem is with smooth grey bark which exudes whitish coloured watery latex when cut (Gawri & Upadhyay, 2012). Plant has short and little branched roots. Normally, the seedlings have 5 roots, 1 central and 4 on the periphery. Flowering normally occurs once a year, during rainy season but in permanently humid areas or under irrigation it flowers throughout the whole year (Kumar and Sharma, 2008). Inflorescences presenting male and female organs on the same plant. Both flowers are small. Each inflorescence shows a cluster of about 5 to 10 fruits. Each fruit is about 40 mm long and contains three seeds. It takes three to four months after the flowering for the seeds to mature. The seeds are black, measuring on average 18 mm in length, 12 mm in width and 10 mm in thickness (Fact Foundation, 2009a). The seed yield per tree is reported to range from 0.2 to 2.0 kilos per year (Brittaine, 2010).



Phytochemistry of Seed

The seeds contain chemical compounds such as saccharose, raffinose, stachyose, glucose, fructose, galactose and protein. The oil is largely made up of oleic and linoleic acids. *Jatropha curcas* also contains curcasin, arachidic, linoleic, myristic, oleic, palmitic, and stearic acids (Perry, 1980). Curcin and phorbol ester are toxic compounds contained in the *Jatropha* meal. The seed kernels of *Jatropha curcas* contain a high amount of oil [58-60% (w/w)] (Aderibigbe *et al.*, 1997) and serve as a potential source of biodiesel.

Traditional Medicinal Uses

Jatropha curcas is widely used in traditional medicine in Africa, Asia and Latino America to cure various ailments such as skin infections, diarrhoea, gonorrhoea, fever and several other diseases caused by microorganisms (Burkill, 1994). Different parts of *Jatropha curcas* have been used in treatment of different forms of infection such as the leaves decoction is used as antiseptic substance during birth, the root decoction is used to treat sexually transmitted diseases and the seed is used to treat skin diseases (Gubitz *et al.*, 1999). The expressed oil of seed have been used as a purgative and as a remedy against syphilis. The viscid sap (latex) is employed to cure sores on the tongues of babies and for reducing toothache (Burkill, 1994).

Biological Activity

Some important phytochemicals such as saponins, steroids, tannins, glycosides, alkaloids and flavonoids present in different part of *J. curcas* are known to be biologically active and therefore these compounds aid a wide variety of interesting biological and pharmacological activities for the secondary metabolites such as antimicrobial activities (Igbinosa, 2009), the fungitoxic activity (Makun *et al.*, 2011), antioxident activity (Oskoueian *et al.*, 2011), anti-cancerous properties (Li *et al.*, 2003), anti-inflammatory activity (Oskoueian *et al.*, 2011), anti-diarrheal activity (Akinpelu, 2009), antiulcer activity (Jaikumar *et al.*, 2010), analgesic activity (Gawri and Upadhyay, 2012). These groups of phytochemicals in plants have amazing effects on humans and this has led to the development of powerful medications.

Some Other Uses of *Jatropha Curcas*

1. The oil is being extensively used for making soap in some countries because it has a very high Saponification value.
2. The oil is used an illuminants as it burns without emitting smoke.
3. From the bark of *jatropha curcas* a dark blue dye is produced which is used for coloring cloth, fishing nets, etc.
4. The byproduct of Jatropha seeds contain high nitrogen, phosphorous and potassium which is used for fish foods, domestic animals food and in lands as fertilizer.

Nowadays it is found that Jatropha may display certain anti-tumour and anti-malarial properties and research is advancing related to HIV/ AIDS, alternative fuels, other than being renewable, are also required to serve to decrease the net production of carbon dioxide (CO_2), oxides of nitrogen (NOx), particulate matter, etc., from combustion sources (Kazi, M. Rahman *et al.*, 2010).

Jatropha: Biodiesel

The harvested Jatropha seeds are used for production of Jatropha oil and biodiesel. The first step is to extract the oil in the seeds which can later be converted into biodiesel.

Oil Extraction

There are two different options for extracting oil from the Jatropha seeds: mechanical extraction and chemical extraction. In both cases the seeds have to be dried prior to extraction, either in an oven or in the sun (Achten, 2008).

Conversion to Biodiesel

The most common method is to convert the Jatropha oil into biodiesel through transesterification. This method transforms an ester into another ester; in this case a reaction between Jatropha oil and methanol is used to produce a methyl-ester (biodiesel) with glycerol as a by-product. The biodiesel can be used directly in a diesel engine or in a blend with conventional diesel (Siddharth, 2009; Achten, 2008).

By-products and Their Uses

There are three important by-products from the production of biodiesel from Jatropha: the seed husk from the seed production, the seed cake produced in the oil extraction and the glycerol from the transesterification.

(a) Seed Husks

The seed husks that are removed before oil extraction can be used directly for combustion. Fuel characteristics are reported to be comparable to those of wood (Achten, 2008).

(b) Seed Cake

Remaining from the oil extraction from seeds and kernels is a seed cake. The seed cake contains high quality proteins (Achten 2008) but also various toxins which make it unsuitable as a fodder. However, the meal can be suitable for animal feed after a detoxification process (Gaur *et al.*, 2011).

Studies show that the seed cake is rich in plant nutrients which make it valuable as an organic fertilizer (Planning Commission, 2003). The toxins make it work as a biopesticide (Achten, 2008).

(c) Glycerol

Glycerol is produced in the transesterification of Jatropha oil into biodiesel. The glycerol can be used to produce heat by combustion, but it can also be used in the cosmetic industry as a feedstock for production of soaps and other products (Achten, 2008).

Conclusion

Because of the above stated properties, *Jatropha Curcas* may be more suitable than other crops for production of biodiesel as well as a wide variety of interesting biological and pharmacological activities have made this plant multipurpose and commercially significant shrub.

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