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Jatropha curcas L.: Substitute for Conventional Energy

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Abstract: *Jatropha curcas* L. or physic nut belonging to family *Euphorbiaceae* is an all purpose, zero waste perennial plant. It is considered as a potential source of non-edible fuel producing plant along with its different medicinal properties and grows well in the tropical and subtropical climate in India. The seed contains 40-50 % viscous oil known as 'curcas oil'. Petroleum based fuel are limited reserves concentrated in the certain regions of the world and these are the major cause of air and sound pollution. Depleting reserves of fossil fuel and increasing effects of environment pollution from these fuels demands eco-friendly alternatives. Methyl esters of fatty acids or biodiesel have several outstanding advantages among other non-renewable and clean engine fuel alternatives and can be used in any diesel engine without any modification. It can be made from any biological sources such as vegetable oils and animal fats.

Key words: *Jatropha curcas* · Biodisel · Oil · Biofuel

INTRODUCTION

It is matter of concern that demand for fuel oils and the pollution level are ever increasing in global level due to high speed diesel. Needless to say, the oil import bill has serious consequences on the Indian economy. However, reserves of crude oil are rapidly diminishing and the reliability and security of oil supplies has been of global concern. India ranks sixth in the world in terms of energy demand accounting for 3.5 per cent of the world commercial energy demand in 2001. The energy demand is expected to grow at 4.8 per cent. Diesel forms nearly 40 per cent of the energy consumed in form of oil. The demands for diesel components are estimated around 40 million tones. The current annual import bill of crude oil in terms of foreign exchange is around Rs. 60, 4000 crores. India produces only about 30 per cent of its annual crude oil requirement of 105 MT, relying on import to the tune of Rs 90,000 crores per annum for meeting the remaining requirement. Plant based fuels are biodegradable, non-toxic and possesses low emission profiles. It has become more attractive because of its environmental benefits and renewable resource [1]. In the present scenario, giving Biofuel (Plant based fuel) as a serious consideration as potential energy sources for the future is the most logical steps as they are renewable and environmentally safe [2].

Large harvest of traditional crops, low farm prices, dependency on foreign energy sources and environment problems have increased interest in energy generated from plant sources such as biodiesel. The major benefit of biodiesel production is that there is no need to follow the uni-focal approach of concentrating and utilizing the same vegetable oil in each and very corner of the globe.

However, since Indian economy depends mainly on agricultural activities, the utilization of national resources for energy production is an extremely important issue. Diesel engines have been widely used as power of engineering machinery, automobiles and shipping equipments for its excellent drivability and thermal efficiency [3]. Diesel fuel are used in heavy trucks, city transport buses, locomotives, electric generators, farm equipments, underground mine equipment, etc. [4].Biodiesel reduces emission of particulate matter by 40-65 per cent, unburned hydrocarbons by 68 per cent, carbon monoxide by 44-50 per cent, sulphates by 100 per cent, polycyclic aromatic hydro carbons (PAHs) by 80 per cent and carcinogenic nitrated PAHs by 90 per cent on an average.

The heating values of vegetable oils are similar to fuel. However, Performance of engine associated problems have been encountered due to several basic properties of vegetable oils, such as naturally occurring

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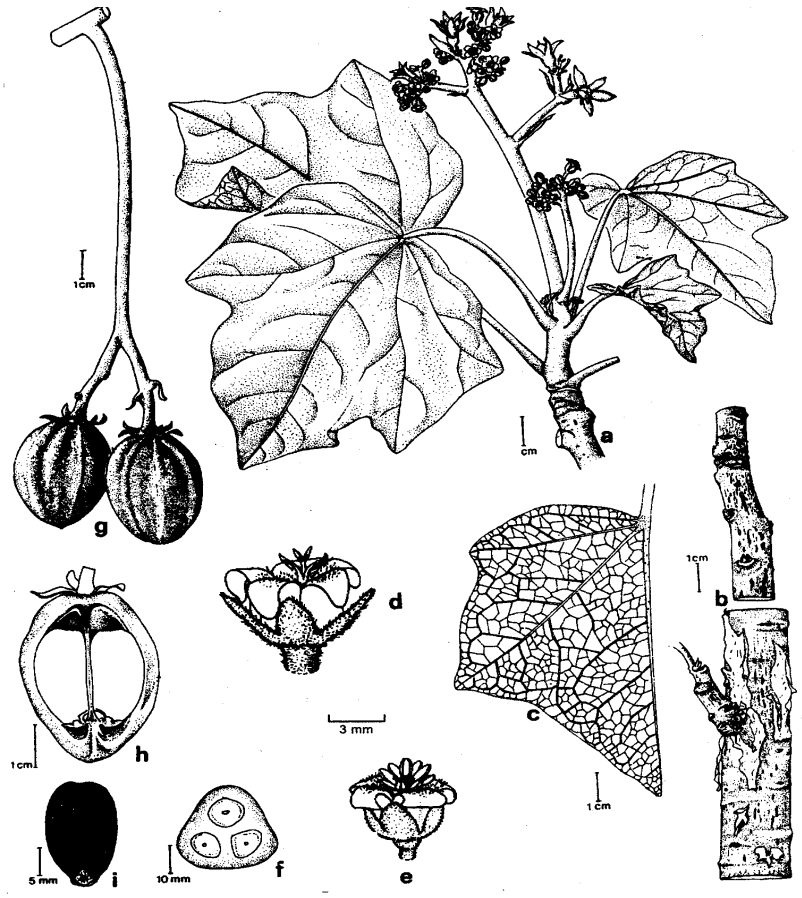

Fig. 1: Different plant parts of *Jatropha curcas*

gums, high viscosity, acid composition, free fatty acid content and low cetane rating. Coking and trumpet formation, carbon deposition, oil ring sticking, thickening and gelling are the basic problems encountered due long term use of biodiesel. Vegetable oils can be used as a fuel for combustion engines, but its viscosity is higher then usual diesel fuel and requires modifications of the engines. Therefore, vegetable oils are converted into their methyl esters by transeterification, which is more suitable for using as a fuel due to low viscosity. The viscosity value of vegetable oils are between 27.2 to 53.6 mm^2/sec., whereas, those of vegetable oils methyl esters (Biodiesel) are between 3.59 to 4.63 mm^2/sec. This low viscosity value of vegetable oil methyl esters are due to transesterification of oil.

In Indian context, the important issue is to grow oilseed tree. The 70 million wasteland in the country are available for plantation of fuel plants. Growing these oil bearing plants on wastelands, as avenue trees and in the back yards all over the nation will improve the availability of these oilseeds crop. Further, local community associated in post harvest processing events may encourage the entrepreneurs to start small industries and to produce raw or finished produced. Biodiesel are extracted from saffola, rapeseed, sunflower and soybean etc. in Australia, Germany and France. In India, non-edible seed crops like karanj, mahua, jatropha are used for production of biodiesel depending on locality [5].but these activities are at initial level. Among non-edible plant species, *J. curcas,* a perennial tree containing high amount of non-edible oil, is considered best for formation of biodiesel.

***Jatopha curcas* L.: Renewable Energy Plant:** *Jatropha curcas* is a small tree or large shrub with smooth gray bark, which exudates a whitish colored watery latex, upon cut. It has large green to pale green leaves, alternate to sub-opposite, three to five lobed with a spirally phylotaxis. Different plant parts of *Jatropha curcas* are shown in Fig. 1.

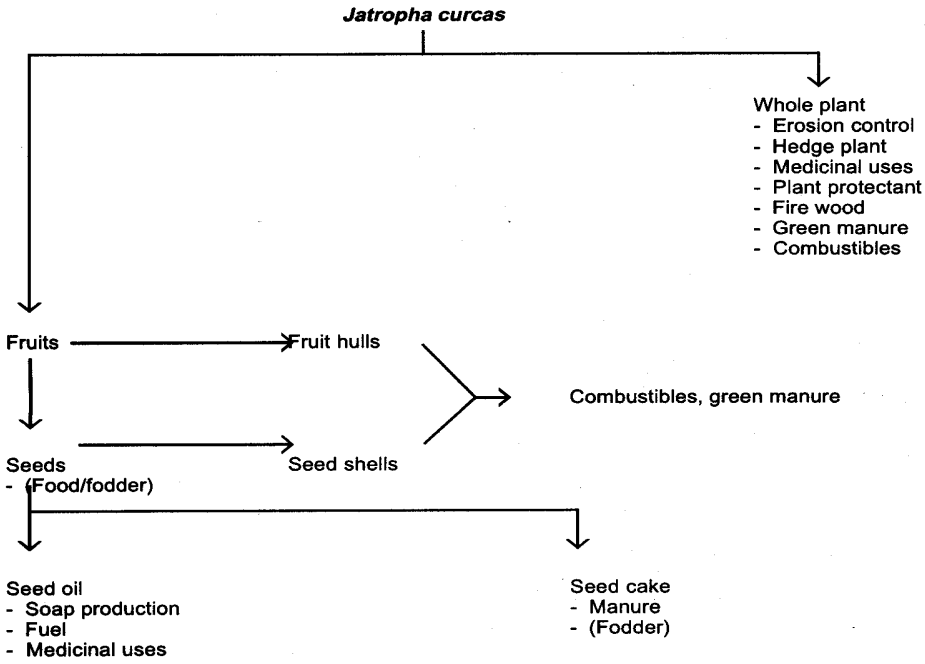

Fig. 2: Different forms of physic nut utilization

The genus *Jatropha* belongs to tribe Joanneasiae of Crotonoideae in the *Euphorbiaceae* family and contains approximately 175 succulents, shrubs and trees (some are deciduous like *Jatropha curcas* L.). It is a multipurpose tree of Mexico and Central American origin with a long history of cultivation in tropical America, Africa and Asia. Madagascar, Dahomey (now Benin) and Cape Verde Islands were major exporters of Jatropha products.

The genus *Jatropha* was derived from the Greek words Jatros (doctor) and trophe (food) which implies medicinal uses. It is a small tree or large shrub, which can grows between 3 to 5 meters in height, but can attain a height up to 8 to 10 meters in favorable conditions. The branches contain latex, normally five roots are formed from seeds, one central (tap root) and four peripheral. Cuttings, when planted do not form tap root. The plant is monocious and flowers are unisexual. Pollination is by insects. The life span of the plant is more than 50 years [6, 7].Jatropha is planted as a hedge (living fence) by farmers all over the world around homesteads, gardens and fields, because it is not browsed by animals [8]. The root, stem, leaves, fruit, seed, bark and latex of the plant are largely used for the treatment of many diseases in different parts of the world [9]. The different uses of Jatropha plant parts are shown in Fig. 2.

Plantation of Jatropha: Freshly harvested seeds show dormancy and complete ripening is necessary before seeds showing. Germination takes place in 10 days under good conditions. Soon after the first leaves have formed, the cotyledons wither and fall down. In the nursery, seeds can be grow in germination beds or in poly begs for easy transportation. Seedlings attain the height of 30-40 cm at the age of 3 month after showing. By then, the plants have developed their alkaloids responsible for repellent smell and at this stage, the plants can not be browsed by animals [10].Normally, five roots are formed from seeds, one central (tap root) and four peripheral. Cuttings, when planted do not form tap root. Early growth is fast and with good rainfall conditions plants grown from seedlings may bear fruits after the first year, whereas, plants produced from seeds start production after second year. When fruits begin to dry, brown colored and start to open, seeds insides are expected to mature. Seeds are collected with hand picking (small trees) and with the help of stick (large trees). Seed yield varies from 0.4 -10 kg / plant / year depending on the age of plant and soil/climatic conditions. Shade dried seeds are separated from seed cover. The seeds are orthodox and should be dried to low moisture conditions and stored in airtight containers. Because of high oil content, seeds can not be expected to store for longer period of time.

Table 1: Fatty acid contents (per cent) of Jatropha, Palm and Coconut oil

Fatty acid	Jatropha	Palm	Coconut
Caprylic acid (C8:0)	_	_	8
Capric acid (C 10:0)	_	_	8
Lauric acid (C12:0)	-	-	48
Myristic acid(C 14:0)	0.38	3.5	16.0
Palmitic acid (C 16:0)	16.0	39.5	8.5
Palmitoleic acid (C 16:1)	1-3.5	-	-
Stearic acid (C 18:0)	6-8	3.5	2.5
Oleic acid (C 18:1)	42-43.5	46	6.5
Linoleic acid (C 18:2)	33-34.5	7.5	2.0
Linolenic acid (C 18:3)	0.8	_	_
Production Kg/ha	1590	5000	2260

Table: 2 Energy content of different biofuel

Sl. No	Biofuel	Energy content (MJ/kg)
I.	Solid fuel	16-21
	• Wood fuel	
ii.	Liquid fuel	
	• Methanol	20-23
	• Ethanol	24-27
	• Butanol	36
	• Biodiesel	3 8
iii.	Gaseous fuel	
	• Methane	55-56
	• Hydrogen	120-140
iv.	Fossil fuel	
	• Coal	29-34

Oil Composition of Jatropha Oil and Biodiesel Formation: Seeds contain different kinds of saturated and unsaturated fatty acids. Fatty acid composition of Jatropha oil as compare to palm and coconut oil are shown in Table: 1.

Biodiesel is an alternative fuel made from vegetable oil and animal fats. It can act as both as substitute and an additive to diesel fuel. Energy content of different biofuels is shown in Table 2. European Union has set an objective to replace its 5 per cent of total motor fuel consumption with biodiesel by 2005. Similarly, the US Department of energy estimated that up to 50 per cent of the diesel fuel could be replaced with biodiesel [11]. In view of economic, environmental and health safety associated with use of biodiesel, it has been decided to strengthen biofuel efforts in India. The targets are being fixed to blend at least 5 per cent and 10 per cent of petrodiesel by biodiesel by the year 2007 and 2015 [2].Different methodologies are used for production of biodiesesl (i. Direct use/blending ii. Micro-emulsion iii. Pyrolysis iv. Transesterification). Transesterification is the most common technique for production of biodiesel (Fig. 3)

Cost of biodiesel varies depending on the basestock, geographical area, variability in crop production, manual power availability, agronomic practices, from season to season and the price of crude petroleum. Biodiesel costs over double the price of diesel. High price of biodiesel is due to the high price of feedstocks, including beef tallow, pork lard and yellow grease. Fatty acid methyl ester could

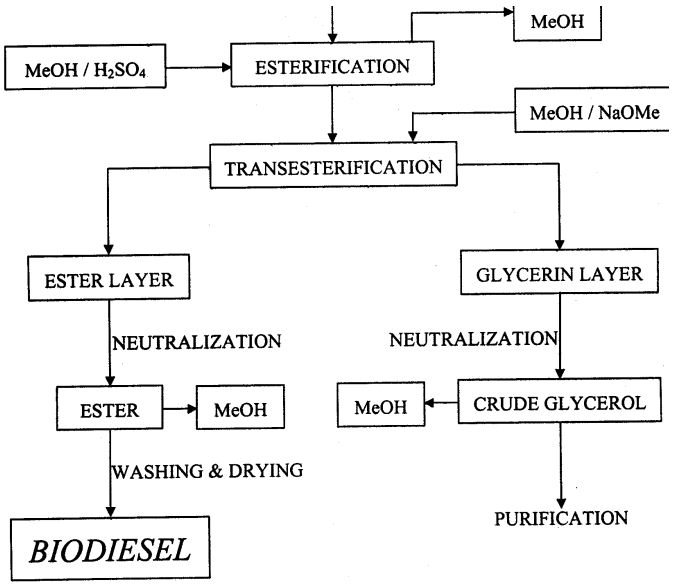

Fig. 3: Transesterification of vegetable oils
(Source: http://en.Wikipedia.org/wiki/Biodiesel)

be produced from tall oil, a byproduct in the manufacture of pulp by kraft process. A review of 12 economic feasibility studies shows that the projected cost of biodiesel from oilseed of animal fat have a range US$ 0.30-0.69 per liter including meal and glycerin credits and the assumption of reduced capital investment cots by having crushing and/or esterification facility added onto an existing grain or tallow facility. Rough projections of the cost of biodiesel from vegetable oil and waste grease are US$ 0.54-0.62 per liter and US$ 0.34-0.41 per liter with pre tax diesel priced at US$ 0.18 per liter in the US and US$ 0.20-0.24 per liter in some European countries. Biodiesel, is thus currently not economically feasible and more research and technology development will be needed [12].

CONCLUSION

The economy vibrancy of a country is indicated by its energy consumption. Oil is the major source of energy for the entire world as it is convenient to store and handle. During the 21st century, an alarming scarcity is supposed to come in the production of crude petroleum oil and they will be costly to produce and at the same time there will likely to be an increase in the number of automobiles and other internal combustion engines. It has been made mandatory to used biodiesel with the diesel and alcohol in petrol to initially minimize the cost of import

A variety of plants have been identified as energy sources. *Jatropha Curcas L.* (Ratanjot) considered as a wild oilseed plant of the tropics and subtropics is now being credited as a most promising biofuel crop, ideally suited for growing in the waste lands of the country. This potential biodiesel crop can be about major economic activity providing income and employment opportunities to the rural communities.

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