An Initiative to Find Better Energy Option for Growing India: Jatropha Oil

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Abstract

Energy is vital role input for economic growth in industries and agriculture. Fossil fuel are depleting at a faster rate due to exploitation besides increasing the environmental protection cost. Search for renewable energy source and their technology development is of paramount importance to have a balanced and buoyant environment for better quality of life. Thus this situation compels us to explore new avenues which can be used as fuel for Diesel Engines. The esters of vegetables oil and animal fats are known as Bio diesel and these are basically used as an alternative fuel for Diesel Engines.

This Paper deals with the prospects of obtaining Bio diesel from Jatropha Oil. Jatropha Curcas is a renewable non- edible plant, which can be seen as a wild hardy plant grown in the arid and semi-arid regions of the country. This can easily be grown on the degraded soils having low fertility and moisture. The Jatropha seeds are very useful since they contain 50-60% oil. To conclude, this study will discuss the process of conversion of Jatropha Oil into Biodiesel by using transesterification process.

1. INTRODUCTION

JatrophaCurcas is a non edible oil crop predominately used to produce the bio-diesel. Besides the production of bio-diesel, the by-product of Jatropha Curcas' trans-etherification process may be used to make a wide range of products which include the high quality paper, energy pellets, soap, cosmetics, toothpaste, embalming fluid, pipe joint cement, cough medicine and as a moistening agent in tobacco.The Jatropha Curcas seed cake which is the waste by-product of the bio-diesel Trans etherification process can be used as a rich organic fertilizer [1].

Biodiesel is defined as a Trans-esterified renewable fuel derived from vegetable oils or animal fats with properties similar or better than diesel fuel. A lot of research and demonstration projects have shown that it can be used pure or in blends from with conventional diesel fuel in unmodified diesel engine. Bio-diesel commands crucial advantages such as technical feasibility of blending in any ratio with petroleum diesel fuel, use of existing storage facility and infrastructure, superiority from the environment, emission reduction angle, capacity to provide energy security to remote and rural areas and employment generation. There are more than 350 oil bearing crops identified, among which only Sunflower, Karanja, Soybean, Cottonseed, Rapeseed, Jatropha curcas and Peanut oils are considered as potential alternative fuels for Diesel engines. So a particular crop which is available in surplus within the country should be used to produce Bio-diesel [2-3].

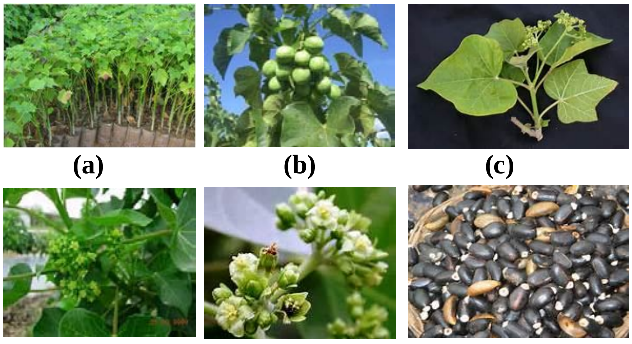

Fig.1: Important part of Jatropha nut: a) plant b) seedlings with root c) leaf venture d) flowering branches e) Seeds

1.1 Jatropha climate and Soil

JatrophaCurcas grows well with more than 60mm rainfall per year and it can withstand long periods of drought as well. The plant sheds its leaves during a prolonged dry season. Jatropha Curcas prefers temperatures range of 20-28^{0}C. Jatropha can be grown in wide range of soil under tropical, subtropical zones [16].

1.2 Jatropha Cultivation

The best time for planting jatropha is in the warm season before and start of the rains. Plant growth is depend upon soil fertility and rainfall. Poor nutrient will lead to increased failure of seed developments it is important to maintain soil fertility. The spacing requirement will vary over different agro climatic regions and soil types.The per plant seed yield increase significantly with increase in spacing but per unit area it decrease with increased spacing The optimum spacing should be (2 m X 2 m) [4].

1.3 Harvesting and Processing

Seeds can be harvested one year after planting.is is best to harvest the fruits when their color turned yellow to dark brown. seeds can be stored up to one year at room temperature[12].

1.4 Use of Various parts of Jatropha

The jatropha oil can be used for soap production and cosmetics production in rural areas. The oil is a strong purgative, widely used as an antiseptic for cough, Skin diseases and as a pain reliever from rheumatism. Jatropha oil has been used commercially as a raw material for soap manufacture for decades, both by Large and small industrial producers. When jatropha seeds are crushed, the resulting jatropha oil can be processed to produce a high quality biodiesel that can be used in a standard diesel car, while the residue (press cake) can also be processed and used as biomass feedstock to power electricity plants or used as fertilizer (it contains nitrogen, phosphorous and potassium)[5].

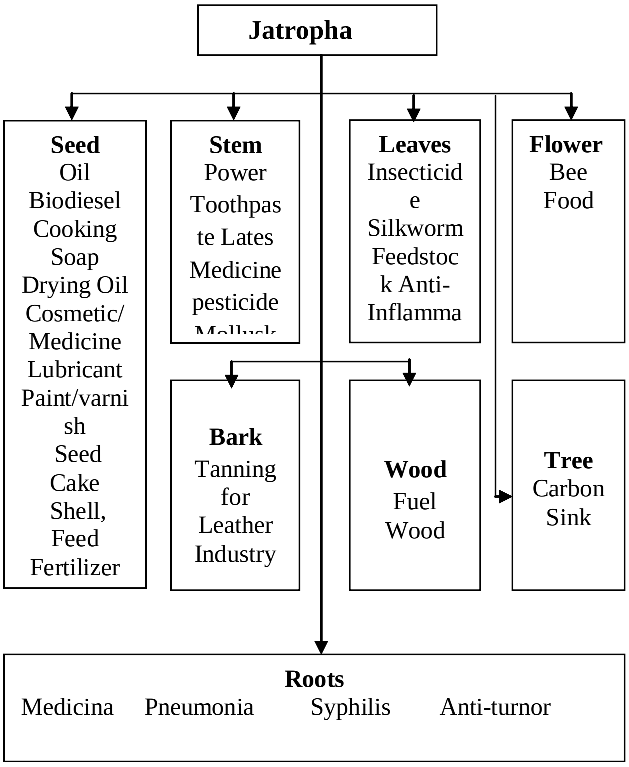

Fig.2: Flow chart of uses of different parts of Jatropha plant

2. METHOD OF PRODUCING JATROPHA BIO-DIESEL:TRANSESTERIFICATION

Transesterification is the process to produce Biodiesel. Transesterification is the commonly use

Commercial process to produce clean and environmental friendly fuel.

The methods used to reduce the viscosity are:

2.1 Blending

2.2 Emulsification

2.3 Pyrolysis

2.4 Transesterification Process

2.1 Blending

Vegetable oil is directly mixed with diesel oil and can be used as fuel for diesel vehicle and other engines. The blending of vegetable oil with diesel oil in various ratio were experimented successfully by researchers. Blend of 20% vegetable oil and 80% diesel have shown similar results as diesel fuel and also properties of the blend are very close to diesel fuel. The blending of vegetable oil with more than 40% has shown an appreciable reduction in flash point due to increase in viscosity. To reduce the viscosity some researchers suggested for heating of the fuel to some extent. Although short term tests using clean vegetable oil showed auspicious results but longer tests led to injector coking, more engine deposits, ring sticking and thickening of the engine lubricant [15].

Micro-emulsification, pyrolysis and transesterification are the remedies used to solve the problems encountered due to high fuel viscosity. Despite the fact that there are numerous ways and systems to change over vegetable oil into a Diesel like fuel, the transesterification procedure was observed to be the most suitable oil modification process. [8]

2.2 Emulsification

To take care the issue of high viscosity of vegetable oil, micro emulsions with solvents such as methanol, ethanol and butanol have been utilized. A micro emulsion is defined as the colloidal equilibrium dispersion of optically isotropic fluid microstructures with dimensions generally in the range of 1–150 nm formed spontaneously from two normally immiscible liquids and one or more ionic or non-ionic amphiphiles. These can improve spray characteristics by explosive vaporization of the low boiling constituents in the micelles. All micro emulsions with butanol, hexanol and octanol will meet the maximum viscosity limitation for diesel engines[2].

2.3 Pyrolysis

Pyrolysis is the process of conversion of one substance into another by means of heat or with the aid of catalyst. It involves heating in the absence of air or oxygen and cleavage of chemical bonds to yield small molecules. The pyrolyzed material includes the vegetable oils, animal fats, and methyl esters of fatty acids. The pyrolysis of fats has been discovered for more than 200 years, especially in those areas of the world that lack deposits of petroleum. Since World War I and World War II, many researchers have studied the pyrolysis of vegetable oil to obtain better products for engine fuel application. Tung oil was saponified with lime and then thermally split to yield crude oil, which was refined to produce diesel fuel and small amounts of gasoline and kerosene[3]

2.4 Transesterification Process

The conversion of Jatropha oil into its methyl ester can be accomplished by the transesterification process.Transesterification involves reaction of the triglycerides of Jatropha oil with methyl alcohol in the presence of a catalyst Sodium Hydroxide (NaOH) to produce glycerol and fatty acid ester[7].

3. INDIAN MARKET

Biofuels are going to play an extremely important role in meeting India's energy needs. The country's energy demand is expected to grow at an annual rate of 4.8 per cent over the next couple of decades. Most of the energy requirements are currently satisfied by fossil fuels – coal, petroleum-based products and natural gas. Domestic production of crude oil can only fulfill 20-22 per cent of national consumption. In fact, India's crude oil import bill is expected to increase 23% from \$70 billion in 2016-17 to \$86 billion in 2017-18 considering Indian basket crude oil price of \$55 a barrel and rupee-dollar exchange rate of 65 for the balance part of the financial year[13].

India's biofuel policy is mostly confined to Jatropha based biodiesel, as the demand for diesel in India is five times more than the demand for petrol. The Planning Commission of India had set an ambitious target covering 11.2 to 13.4 million hectares of land under Jatropha cultivation.The policy seeks to increase the demand for biodiesel to 16.72 million tons by 2017 and encourages 20% blending of biodiesel with other fuels. This is a major challenge as Jatropha is a new perennial crop for the farmers, who see considerable risk and uncertainty in its production, profitability and employment generation.

Table-1: Projected Share of Jatropha Biodiesel in Total Biodiesel Production

Year	Total Projected Supply of Jatropha (MMT)	Total Biodiesel Production (MMT)	% of Biodiesel Supplied by Jatropha
2009	0.5	16.9	3.0
2010	2.1	20.2	10.4
2012	6.5	29.2	22.3
2015	15.5	50.3	30.8

3.1 Benefits from the use of biofuels in India

3.1.1 Reduced emission of harmful pollutants

Ethanol and biodiesel are both oxygenated compounds containing no sulphur. These fuels do not produce sulphur oxides, which lead to acid rain formation. Sulphur is removed from petrol and diesel by a process called hydro-desulphurization. Since ethanol and biodiesel contain oxygen, the amount of carbon monoxide (CO) and unburnt hydrocarbons in the exhaust is reduced [6][11].

Table-2: Comparison of emissions from 22 per cent ethanol (E22) and 100 per cent hydrated ethanol (E100)

Comparison of emissions from 22 per cent ethanol (E22) and 100 per cent hydrated ethanol (E100) with legal limits			
Parameter	**E22**	**E100**	**Legal Limits, India (Euro IV/Bharat IV)**
Carbon Monoxide (g/km)	0.76	0.65	1.5
Unburned Hydrocarbons (g/km)	0.13	0.15	0.46
NO_x (g/km) Aldehydes (g/km)	0.45	0.34	3.5
Aldehydes (g/km)	0.004	0.02	
Evaporative (g/test)	0.86	1.6	
Particulate Matter (g/km)	0.08	0.02	0.02
Sulphur Dioxide (g/km)	0.064	0	

3.1.2 Reduction in greenhouse gas emissions

The net CO2 emission of burning a biofuel like ethanol is zero since the CO2 emitted on combustion is equal to that absorbed from the atmosphere by photosynthesis during the growth of the plant (sugarcane) used to manufacture ethanol[8-10].

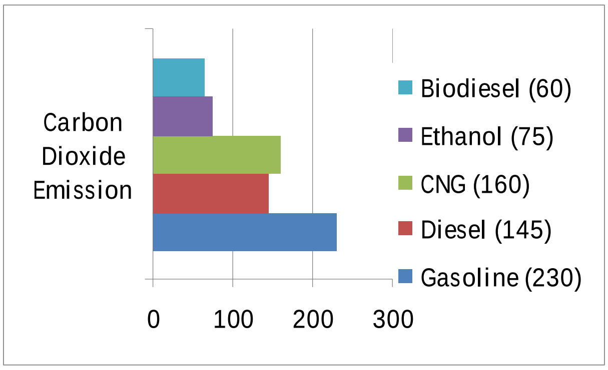

Fig.3: Carbon dioxide emission, g/km (Source Planning commission 2003)

3.1.3 Improved social well-being

large part of India's population, mostly in rural areas, does not have access to energy services. The enhanced use of biofuels in rural areas is closely linked to poverty reduction as greater access to energy services can:

1. Improve access to pumped drinking water;
2. Reduce the time spent by women and children on basic survival activities (gathering firewood, fetching water, cooking, etc);
3. Allow lighting for increased security and the night time use of educational media in school and home study; and
4. Reduce indoor pollution caused by firewood use, together with a reduction in deforestation.

4. PROPERTIES OF JATROPHA BIODIESEL & DIESEL FUEL AND THEIR COMPARISON

The tabeNo.3 show a brief comparison between Jatropha biodiesel and diesel fuel [14].

Table-3: Comparison of Jatropha Biodiesel & Diesel fuel

Specification	Diesel	Jatropha Oil
Specific Gravity	0.82-0.84	0.9186
Flash point	50^0C	$240/110^0$C
Carbon residue	0.15	0.64
Cetane value	50	51.0
Distillation Point	350^0C	295^0C
Kinematic Viscosity	2.7cs	50.73cs
Sulphur %	1.2%	0.13%
Calorific Value	1017kcal/kg	9470kcal/kg
Pour Point	10^0C	8^0C
color	4 or less	4.0

5. CONCLUSION

1. Biodiesel is a alternate substitute for diesel fuel. its advantages are improved higher cetane number, lubricity, reduced global warming and increases rural development.[2]
2. Jatropha oil is a clean fuel reducing greenhouse gas emission (CO,HC) and reduces engine wear And biofuels also improve vehicle performance biodiesel lubricity actually extends the life of diesel engines.
3. Jatropha oil provides energy for light, transportation and cooking.
4. Glycerin,a by product of Jatropha oil, can be used to produce soap.
5. Jatropha oil is non-ediable,it is cheap and abundantly available.
6. Properties of Jatropha biodiesel is improved by the process of transesterification.

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