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Evaluation of various plant species for biodiesel production

S.P. Ingole and A.U. Kakde

Department of Environmental Science, Shri Shivaji Science College, Amravati (M.S.), India

Abstract

Fuels are the combustible substances containing carbon, hydrogen as the main constituents. The biomass consists of these carbonaceous materials as the chemical form. In this recent new era when we are facing short listing of conventional fuels, a substitute is urging. Newer inventions and research works are being carried out by various agencies. The biofuel concept is found much helpful, sustainable and environmental friendly. Some members of *Euphorbiaceae*, some algal species, sugarcane, residues and sugar beet are remarkable in this field. Biomass has been used for energy purposes ever since man discovered fire. With the evolutionary trend man discovered the conventional fuels and started its consumption. The over consumption of these fuels have brought up to the condition that today these fuels are depleted and stocks towards end. To cope up with these conditions, a newer technological concept is to develop the fuels, which are never ending. This need can be fulfilled by the use of non-conventional fuels or resources. Biomass is likely to remain as an important global source in developing countries well in the next century. Some species of petro plants have been found fruitful and a bless in the route. A powerful option for improving our environment while reducing dependence on foreign fuels, and the stretching fossil fuel reserves in the biodiesel. Biodiesel is a clean burning fuel for diesel engines made from domestically produced, renewable fats and oils such as *Soybean oil, Jatropha, Pongamia pinnata,* and various other species. The aim and purpose of developing these plant species is to incorporate such species, which are economical, beneficial and having potency to grow even in the drastic conditions. India is a country of vast diversity, blessed with all types of vegetation: tropical, subtropical, temperate and alpine. Keeping in mind its economic and development status, some species like *Pongamia pinnata, Jatropa curcas, Shorea robusta, Madhuca indica, Pongamia glabra, Azadirachta indica, Magnifera indica, Salvadora oleoides*, some grasses like *Andropogon, Cymbopogan, Lemon grasses*, etc. The oil extracted from these species particularly the *Jatropa and Pongamia pinnata* has environmental as well as economical benefits. These species are found growing, luxuriantly even in the desertified, barren and waste lands. The oil obtained from the species can be used for lightening lamps, electrification and as a biodiesel for automobiles. Maintenance cost and cost of production are negligible. As expensive can help in employment for locals and increasing soil fertility and green patches of these can be developed for substance of good, healthier environment.

Keywords: Biomass energy, Biodiesel, Non-conventional, Eco friendly.

INTRODUCTION

For many years now, people have accepted air pollution as the price of progress. But times have changed. There is new understanding of the impact of airborne pollutants have on human health, clean air, practical, economical and environment. As U.K. rises to meet the challenges, Biodiesel is emerging as a solution to the problem.

Nearly half the world's poorest people live on marginal lands with the number expected to increase from 500 million to 800 million by 2020. These areas are by definition isolated and fragile, with soils susceptible to erosion and subjected to environmental stresses of deforestation, prolonged droughts, and decreasing soil and ground water. Although southern Africa is rich in biodiversity and production potential, large areas are under semiarid and arid conditions with a moderate-to-high risk of drought. Plants species like Jatropha that can grow on lands not usually attractive for agriculture and supply raw material for industry, fuels for basic energy services and improve environment are therefore an obvious choice that needs to be assessed carefully and comprehensively [1].

As India is deficit in edible oils. Non-edible oil may be material of choice for producing bio-diesel. Bio-diesel is an eco-friendly, alternative diesel fuel prepared from domestic renewable resources that is vegetable oil, (edible or non-edible oil) and animal fats. These triglycerides when reacted chemically with lower alcohols in presence of a catalyst result in fatty acid esters. These esters shows striking similarity to petroleum derived diesel and are called 'Bio-diesel'. Bio-diesel is produced by transesterification of oil obtained from the plants. Just like petroleum diesel, bio-diesel operates in compression ignition (diesel) engine, which essentially require very little or no engine modifications because bio-diesel has properties similar to petroleum diesel fuels. It can be stored just like the petroleum diesel fuel and hence does not require separate infrastructure. The use of bio-diesel is conventional diesel and in engines results in substantial reduction of unburned hydrocarbons, carbon monoxide and particulate matters. Bio-diesel is considered clean fuel since it has almost no sulphur, aromatics and has about 10% built in oxygen, which helps it to burn fatty. Its higher cetane number improves the ignition quality even when blended in the

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*Corresponding Author
S.P. Ingole
Department of Environmental Science, Shri Shivaji Science College, Amravati (M.S.), India

Email: sangita_pi@rediffmail.com

petroleum diesel [2].

Jatropha is a fast growing plant and can achieve a height of three meters within three years under a variety of growing conditions. Seed production from plants propagated from seeds can be expected within 3-4 years. Use of branch cutting for propagation is easy and results in rapid growth; the bush can be expected to start bearing fruit within one year of planting [3]. The only renewable alternative diesel fuel that actually reduces a major green house gas components in the atmosphere. The use of biodiesel will also reduce the fall emissions. Carbon monoxide, ozone forming hydrocarbon, acid rain causing sulfur dioxide, life cycle of carbon dioxide. Biodiesel is a furthermore a completely biodegradable product, easy and safe to use.

Barnwal and Sharma (2005) [4] in their work made an attempt has been review and discusses the work done on biodiesel production and utilization, resources available, process(es) developed/being developed, performance in existing engines, environmental considerations, the economic aspect, and advantages in and barriers to the use of biodiesel.

PLANT SPECIES

For the purpose of fulfilling the needs, ecofriendly fuels obtained from plants like Pongamia pinnata, Jatropha curcas, Shorea robusta, Madhuca indica, Mangnifera indica, Salvadora oleoides, Soyabean, Rice bran oils, Sunflower, Peanut, Coconut, Linseed, Palm, Olive, Corn, Castor, Seasame, Calophyllum inophyllum (Nagchampa), Hevca brasiliensis (rubber), some grasses like Andropogan, Cymbopogan, Lemon grasses, etc.

Eight common aquatic weeds *Salvinia molesta, Hydrilla verticillata, Nymphaea stellata, Azolla pinnata, Ceratopteris* sp. *Scirpus* sp. *Cyperus* sp. and *Utricularia reticulata* were digested anaerobically to produce methane. The carbon to nitrogen (C/N) ratio, carbon to phosphorus (C/P) ratio, and the volatile solids (VS) content of the weeds varied widely [5].

CONDION REQUIRED FOR GROWTH

The above plant species are found wild in nature in almost every region and is used as a hedge mostly from animals. Domestic or wild animals do not relish it, brid do not harm it. Majority of lands and climates are suitable for its growth. These plants species can face sufficiently hot, dry, semi dry, cold, frosty and fog weather. Even these plants are useful for improving the quality of land and can be successfully grown on unused barren land.

Organic manures like farmyard manure compost, vermin-compost, green leaf manure etc. to achieve sustainability. In poor to normal fertility land apply 10 to 15 tons / hr. farmyard manure compost on 4/5 tons/hr of vermin-compost at time of land preparation.

One – foot deep and 2 meter wide channel joining the pits should be made for irrigation. In rained and wastelands the plants should be irrigated in initial 1-2 years. Latter on they may not require much irrigation in normal rainfall years, but during drought years irrigation by deep system or any other water saving system should be applied.

Bio-diesel can be manufactured in the rural areas because of the wasteland and cheap labor availability.

PROCEDURE FOR PRODUCTION OF BIO-DIESEL

The Bio-diesel production involves mainly two steps.

- Extraction of oil from seeds.
- Conversion of vegetable oil to bio-diesel.

The extraction of oil can be done in any suitable oil extraction unit. Commonly used oil extraction units can be used for extraction of oil from plants like Jatropha, Karanj etc. The second step of conversion of vegetable oil to bio-diesel requires chemical processing plant. The operation of this plant requires specific training and this can be done by well-trained engineers/diploma holders/chemists.

Transesterification is nothing but a simple chemical reaction of the oil with an alcohol to remove the glycerin, which is a by-product of bio-diesel product. Trans-esterification is called alcoholysis, is the displacement of alcohol from an ester by another alcohol in a process similar to hydrolysis. This process has been widely used to reduce the viscosity of triglycerides. The trans-esterification reaction is represented by the general equation, which is the key reaction for bio-diesel production.

RCOOR' + R"RCOOR" + R'OH

If methanol is used in the above reaction, it is termed methanol sis. Triglycerides are readily trans-etherified in the presence of alkaline catalyst at atmospheric pressure and temperature of approximately 60-70 C with an excess of methanol. The mixture at the end of the reaction is allowed to settle. The excess methanol is recovered by distillation and sent to a rectifying column for purification and recycled. The lower glycerol layer is drawn off while the upper methyl ester layer is washed with water to remove entrained glycerol. Methyl esters of fatty acid are termed as bio-diesel [6]. Lipases are active on a water/lipid interface and in this respect differ from esterase enzymes which cleave only water-soluble esters, such as triacetylglycerol. Lipase activity is detected in, for example, milk, oilseeds (soybean, peanut), cereals (oats, wheat), in fruits and vegetables and in the diggestive tract of mammals. Many microorganisms release lipase-type enzymes into their culture media, and these may contribute to enhance the deterioration of foods. Concerning antioxidant employment, recent efforts are focused on the replacement of synthetic antioxidants by natural ones, which may provide nutritional and therapeutic effects [2].

As to specifity, fat-splitting enzymes, which preferentially cleave primary HO-group esters are distinguished from those which indiscriminately hydrolyse any ester bonds of acyl glycerols. Many developed countries have active bio-diesel program. Currently biodiesel is produced mainly from field crop oils like rapeseed, sunflower etc. in Europe and soybean in US, Malaysia utilizes palm oil for bio-diesel production while in Nicaragua it is jatropha oil. The globally and in India are given in table 1 and 2.

Table 1. Global production of the major vegetable oils (2001)

Oil	Production (Million Tons)
Soyabean	27.8
Rapeseed	13.7
Cotton seed	4.0
Sunflower	8.2
Peanut	5.1
Coconut	3.5

Linseed	0.6
Plam	23.4
Plam kernel	2.9
Olive	2.7
Corn	2.0
Sesame	0.8
Total	95.2

Table 2. Vegetable Oil production in India (2001)

Oil	Production (Million Tons)
Groundnut	1.40
Soya	0.82
Rape/mustard	1.55
Sunflower	0.30
Sesame	0.26
Castor	0.25
Niger	0.03
Safflower	0.09
Linseed	0.10
Cotton seed	0.44
Coconut	0.55
Rice bran	0.55
Oil for expelled cake	0.28
Minor oilseeds	0.05
Total	6.67

Table 3. Country wise capacity of the bio-diesel plants

Country	Number of plants	Total Annual capacity '000 tons	Oil used
Austria	11	56.2 to 60	Used frying oil
Belgium	3	241	
Canada	1		
Czech republic	17	42.5 to 45	Used frying oil
Denmark	3	32	
France	7	38.1	
Germany	8	207	
Hungary	17	18.8	
Ireland	9	5	Used frying oil
Italy	9	779	Sunflower
Nicaragua	1		*Jatropha*
Slovakia	10	50.5 to 51.5	
Spain	1	0.5	
Sweden	3	75	
Switzerland	1	2	
U.K.	1		
U.S.A.	40	190	Used frying oil
Yugoslavia	2	5	

ADVANTAGES OF PLANT SPECIES

- Erosion conservation and soil improvement.
- Reduction crop losses caused by wandering livestock or wind damage.
- Increasing rainfall infiltration resulting in teamwork/irrigation water needed for local gardens.
- Increasing use of inexpensive local resources rather than expensive external resources.
- Reducing disputes between farmers and livestock owners regarding crop damage, as well as among farmers themselves regarding the boundaries of their field.
- Providing local jobs, lessening the need for local villagers, migrate to cities to find employment.

IMPORTANCE OF BIO-DIESEL

- It reduces vehicle emission, which makes it eco-friendly. It is made from renewable source and can be prepared locally.
- Increases engine performance because it has higher cetane numbers as compared to petro diesel.
- It has excellent lubricity.
- Increased safety in storage and transport because the fuel is non-toxic and biodegradable. (Storage, high flash pt.)
- Production of bio-diesel in India will reduce dependence on foreign, suppliers, thus helpful in price stability.
- Reduction of greenhouse gases at least by 3.3 kg carbon dioxide equivalent per kg. of bio-diesel.
- The use of bio-diesel will also reduce the following emissions – carbon monoxide, ozone, forming hydrocarbons, hazardous diesel particulate, and acid rain, causing sulphur dioxide, lifecycle carbon dioxide.
- Medicinal like other Euphorbiaceae, *Jatropha* has many toxic compounds (Lectin, Saponin, Carcinogenic phorbol and trypsin inhibitors). The latex are irritants. These compounds in *Jatropha* scare predators and assist the plants to thrive better [7 and 8].

CONCLUSION

Plantation of oil yielding plants such as Jatropha curcas for bio-diesel will result in greeting of waste and follow lands. It thus helps in eco-restoration, drought proofing and environment security. It generates employment opportunities for rural masses thereby providing livelihood support. Bio-diesel acts as renewable source ensures energy security of the country. As far as energy is concerned, it has been discovered that the production process. Starting from cultivation, results in energy gain from a perfectly renewable energy source. Bio-diesel is, further more a completely biodegradable product, easy and safe to use.

Water is an indispensible component, required for existence of life. The quality of water is the factor which decides its use. Various indiscriminate activities, the discharges from the developmental plants, alter the water quality and have caused the pollution of environment.

With the ever increasing demand of petroleum and depletion of their stocks, mankind is facing a global shortage of petroleum fuel. This has forced us to explore the other forms of substitutes of petrol, diesel and other petroleum products. Various tests are performed all over the world on that basis these fuels are similar to conventional diesel and other petroleum products. Fuels are similar to conventional diesel fuels. Ecologically also Biodiesel has been proved advantageous as it is biodegradable.

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