International Journal of Biology Research
ISSN: 2455-6548
Impact Factor: RJIF 5.22
www.biologyjournal.in
Volume 2; Issue 4; October 2017; Page No. 88-90

Jatropha curcas L. as an alternate source of conventional energy

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Abstract
The world's energy demand is consistently increasing due to increasing population. Alternate of fossil fuels are being explored because of diminishing fossil fuel reserves and increasing environmental degradation. Biodiesel is an alternate of petro-diesel which is made by transesterification of vegetable oil or animal fat. It is considered to be eco-friendly fuel as it reduces emission of several pollutants. Biodiesel comprises of mixture of fatty acid methyl or ethyl esters. Though many plants have been examined for biodiesel production but *Jatropha curcas* was found most suitable for developing countries as it can grow in marginal or wasteland. It also has very low gestation period than other oil seed crop.

Keywords: *jatropha*, biodiesel, global energy

Introduction

Global energy consumption

A major percentage of energy used in the world is obtained from fossil fuel. Fossil fuel is a non-renewable energy source, which comprises of oil, natural gas and coal. It is derived from organic matter (plant and animal) which were buried under layers of rock from millions of years. It is reported that world's energy consumption consistently increasing (Figure 1) with annual growth rate of 1.8% (BP statistical review of world energy, 2017). It is expected that world energy consumption will rise nearly by 41% by 2035 (British petroleum outlook 2035, January 2014).

Liquid fuel like petrol and diesel play a vital role in socio-economic development of the country. Globally, the transportation sector is the second largest energy consuming sector after industrial sector and account for 30% of world's total energy consumption (Atanbani *et al.*, 2012) [1]. Transportation and agriculture sectors are largely depends upon liquid fuel. In India, transportation sector consumes nearly 99.6% petrol and 70% diesel whereas agriculture sector account for approximately 13% diesel (Ministry of Petroleum and Natural gas, Government of India). Globally, total oil consumption increased from 3160 million tonnes to 4418 million tonnes between 1990 and 2016 with growth rate of 1% per annum (BP statistical review of world energy, 2017). Similarly, annual consumption rate of coal and gas were found to increase approximately by1.9% and 2.3% respectively (Figure 2).

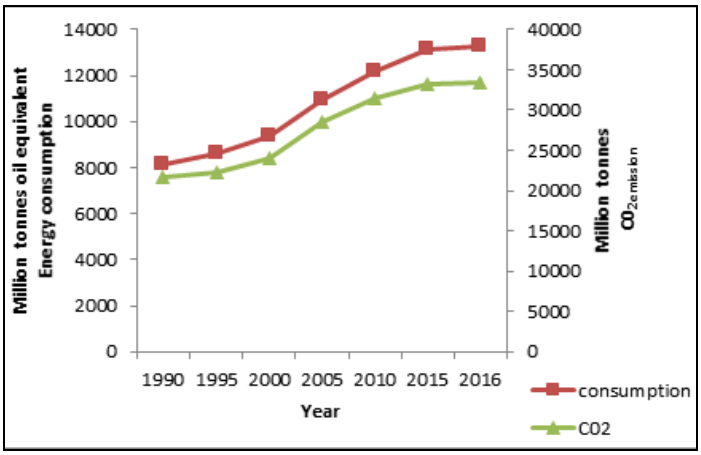

Fig 1: Global energy consumption and CO_2 emission between 1990 and 2016. Source: British Petroleum Statistical Review of world energy 2017.

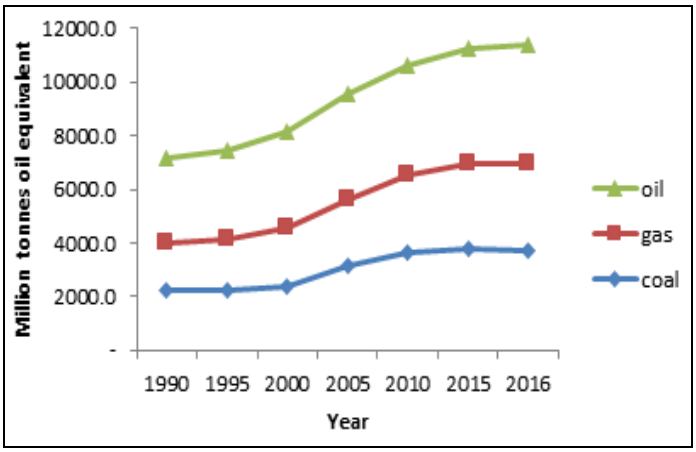

Fig 2: Global oil, gas and coal consumption between 1990 and 2016. Source: British Petroleum Statistical Review of world energy 2017.

The demand of fossil fuel is consistently increasing due to growing population and industrialization (Figure 2). However, Fossils fuel reserves are finite and as demand is increasing it is forecasted that oil, coal and gas would be completely exhausted by 2042, 2112 and 2144 respectively (Shafiee and Topal, 2009) [9]. In addition, combustion of fossil fuels also emits numbers pollutants like CO_2, SO_2, NO_x, CO, polyaromatic hydrocarbons, unburned hydrocarbon and particulate matter which are responsible for environmental degradation. The increase in global CO2 concentration is one of the main factors of global warming. The level of CO_2 has increased approximately by 1.6% between 2005 and 2015 (Figure 1). Therefore, there is a need to harvest energy from alternate sources which are renewable and environtment-friendly.

Biodiesel

Biodiesel is a renewable form of energy and can be used as alternate of diesel. Biodiesel emits lesser pollutants viz: CO_2, SO_2, CO, polyaromatic hydrocarbons, unburned hydrocarbon and particulate matter as compared to petro-diesel (US Energy information administration).

Biodiesel is a mixture of fatty acid methyl esters manufactured by trans-esterification of oil. The trans-esterification can be achieved chemically or enzymetically which reduces viscocity of oil to a level similar to diesel (Srivastava and Prasad, 2000). Biodiesel can be blended and used in many different concentrations, including B100 (pure biodiesel), B20 (20% biodiesel, 80% petroleum diesel) and B5 (5% biodiesel, 95% petroleum diesel). B20 is the most common biodiesel blend in the United States because it represents a good balance of cost, emissions, cold-weather performance and materials compatibility (US, Department of Energy). High-level biodiesel blends (above 20%) can impact on engine warranties, gel in cold temperatures, and suffer from microbial contamination in tanks (US, Department of Energy). Therefore, use of B100 as fuel requires engine modification.

Jatropha Curcas as a biodiesel

Many edible and non-edible vegetable oils have been explored so far for biodiesel production. Edible vegetable oil such as soybean, sunflower, groundnut, rapeseed, palm and peanut are being used in developed countries for biodiesel production (Freedman *et al*., 1986; Lang *et al*., 2001) [6-7]. Currently, more than 95% of the world biodiesel is produced from edible oil such as rape seed (84%), sunflower (13%), palm oil (1%), soybean and others (2%). However, use of such edible oil for biodiesel production is not feasible in long term because of the growing gap between demand and supply of edible oil. Therefore, plant producing non-edible oil may be the material of choice for biodiesel production. Plants such as *Madhuca indica*, *Pongamia pinnata* and *Jatropha curcas* contains toxic compound in their seeds, which makes it unsuitable for human consumption. Among all these plants, *Jatropha curcas* is considered as a best potential source for biodiesel production because of high oil content, easy propagation, drought resistance and ability to grow in wasteland.

Jatropha curcas is a perennial drought resistant shrub belonging to Euphorbiaceae family. There are more than 170 species of Jatropha reported worldwide and most of them are ornamental plants (Ref 1). *Jatropha curcas* is oil bearing plant and contains approximately 30-40% oil. Its oil contains both saturated and unsaturated fatty acids. Saturated fatty acids comprises of Palmitic (10.5- 13%) and Stearic (2.3- 2.8%) acids, and unsaturated fatty acids comprises of Oleic (41.5-48.8%), Linoleic (34.6- 44.4%) and traces of Linolenic acid (Martinez –Herrera et al., 2006). High content of un-saturated fatty acids (76%) in the oil provides low viscosity to derived biodiesel leading to prevention from gelling in cold weather condition. Moreover, most of the properties of *Jatropha curcas* biodiesel meets the specification specified for biodiesel by ASTM D6751 (American standard for biodiesel), EN14214 (European standard for bodiesel) and IS-15607 (Indian standard for biodiesel).

Conclusion

Energy has become a crucial factor for humanity to continue the economical growth and maintain standard of living. The problem of diminishing petroleum reserves and increasing environmental degradation have prompted researcher to search renewable resources as a substitute to petroleum fuel. Biodiesel is an alternate of petro-diesel, obtained from renewable resources and is environmental friendly. *Jatropha curcas* plant is considered as a potential source for biodiesel production because of suitable characteristic.

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