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PRODUCTION OF BIODIESEL FROM *JATROPHA CURCAS* L OIL

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ABSTRACT

Biodiesel consists of monoalkly esters of long chain of fatty acids produced by transesterification of vegetable oil with alcohol (methanol or ethanol). Biodiesel is an environmentally friend renewable diesel fuel alternative. A bench scale production of biodiesel from Jatropha oil (using methyl alcohol and sodium hydroxide as catalyst) was developed with methyl esters yield of 85%. The produced biodiesel was evaluated as a fuel and compared with petroleum diesel according to its physical and chemical parameters to its physical and chemical parameters such as viscosity, flash point, copper corrosion point and density. The fuel properties of the biodiesel produced were found to be near to that of petroleum diesel. Glycerol was produced as valuable byproduct of the process.

INTRODUCTION

World's economy depends upon the burning of fossil fuel equivalent of some 180 million barrels of oil each day. The consumption rate is equivalent to an annual burning of what nature took about one million years to accumulate fossil deposits. The fast depletion of fossil fuel becomes concern and there is a heavy pressure on the engine researcher to find alternative fuels to replace conventional fuels for the developing countries of the world. Stavarache *et al.,* (2007) reported that biodiesel has attracted considerable attention during the past decade as a renewable, biodegradable and non-toxic fuel. Biodiesel is well known chemically as the monoalkly ester of long chain fatty acids and is produced from several types of conventional and non conventional vegetable oil and animal fats (Tomasevic and Silver-Marinkivoc, 2003; Ramadhas *et al.,* 2005). Biodiesel contains no petroleum but it can be blended at any level with petroleum diesel to create a biodiesel blend. It can be used in compression-ignition (diesel) engines with little or no modification. Biodiesel is simple to use biodegradable, non-toxic and essentially free of sulphur and aromatics.

Table 1: Fatty acid contents of Jatropha oil

Fatty acid	structure	weight
Myristic	14:0	0-0.1
Palmitic	16:0	14.1-15.3
Palmitoleic	16:1	0-1.3
Stearic	18:0	3.7-9.8
Oleic acid	18:1	34.3-45.8
Linoleic	18:2	29.0-44.2
Linolenic	18:3	0-0.3
Arachidic	20:0	0-0.3
Behenic	22:0	0-0.3

Source: Gubitz *et al.,* (1999)

The fuel of bioorigin may be alcohol, edible and non-edible vegetable oils, biomass, biogas etc. *Jatropha curcas*, a non-edible oil seed bearing and drought advantage, provides energy self-sufficiency, while reducing fossil fuel consumption and green house gas emissions (Gubitz *et al.,* 1999). Houfang *et al.,* (2009) investigated a two step process consisting of pre-esterification and transesterification to produce biodiesel from crude *Jatropha curcas* L oil. The yield of biodiesel by transesterification was higher than 90% using 1% of NaOH and a molar ration of methanol to oil 6:1 at 65ºC. As a part of our systematic investigations of exploring indigenous vegetable oil resources for biodiesel production efforts were made to evaluate the utility of Jatropha seed oil for biodiesel production.

MATERIALS AND METHODS

Jatropha oil used for the production of biodiesel on bench scale by base catalyst transesterification was extracted at Biodiesel information and demonstration centre, Deptt. of Biotechnology, Gulbarga University, Gulbarga. Methanol of 99.8% analytical reagent was used. The catalyst was sodium hydroxide purified pellets of 97% minimum assay. Fatty acid composition of Jatropha oil has shown in Table 1. Isopropanol of 99.7% purity, phenolphthalein of 1% and NaOH of 99% purity were used for the determination of free fatty acids contents of Jatropha oil. Experiments were conducted using the following apparatus namely the three necked flask, graham condenser, and thermometer, heater completed with stirrer and separator funnel.

Experimental procedure: Initially, the reactor was filled with1000g of Jatropha oil and heat to 65°C.

Analytical procedure: The free fatty acids content of the sample was determined using acid base titration technique. The

Table 2: Comparison of the physico-chemical parameters of the investigated Jatropha biodiesel to ASTM standards

Parameters	ASTM	Crude oil	Transestrified Biodiesel
Color	Gold yellow	Gold yellow	Gold yellow
Viscosity mm^2/s	1.9 – 6.0		5.14
Density	0.86-0.9	0.905	0.875
Acid value	0.8	1.4 ± 0.25	0.74
Flash point	100-170		156
Copper corrosion strip value	No.3 max	No.1	No.1

titration method involved the following method. The neutralized isopropanol was prepared by adding few drops of N/10 NaOH in 50mL of isopropyl alcohol in a clean and dry flask. 10g of oil was measured and heated to about 60ºC. After cooling the oil, the neutralized isopropanol was mixed. Few drops of phenolphthalein indicator was added to the above mixture with shaking and titrated with N/10 NaOH until first permanent pink color appeared (Lin *et al.,* 1995). Determination of FFA was done by the following formulas.

$$\text{FFA content} = \frac{28.2 \text{ x Normality of NaoHx Titration value}}{\text{Weight of the oil}}$$

Methanolysis The reaction was performed using 6:1 molar ratio of alcohol to the oil and catalyst concentration 1% by weight of the oil at 65ºC under stirrer. After 2 hr reaction time, the reaction mixture was carefully transferred to a suitable separating funnel. Two layers were separated after about 6 hr, the one is the glycerol containing layer. The unreacted methanol and catalyst were removed by warm washing. After wash the biodiesel was dried by heating to 100ºC and stored for further analysis. The yield of methyl esters was calculated using the following formula,

$$\text{Yield of methyl esters \%} = \frac{\text{Gram of methyl esters produced}}{\text{Gram of oil used in reaction}} \text{x } 100$$

RESULTS AND DISCUSSION

The quality of Jatropha oil would deteriorate due to the improper handling and storage. Thus, the chemical and physical properties of Jatropha oil changes at times (Berchmans and Hirata, 2007). The value of FFA has been found to increase due to the hydrolysis of triglycerides in the presence of moisture and oxidation. The order to minimize the FFA content of Jatropha oil, the pre- treatment process was conducted in the presence of sulphuric acid. The initial free fatty acid was 5.2% which was minimized to 1.83%.

The biodiesel yield was estimated after the reaction. The produced biodiesel weight relative to the initial used Jatropha oil was taken as the biodiesel yield. Biodiesel with single stage process produced 85% biodiesel and treatment with sulphuric acid 95% of biodiesel was obtained.

Flash point is an important factor to consider in the handling storage, and safety of fuels and flammable materials. The flash point determined to be 156ºC; it is within the prescribed limits in American and European biodiesel standards.

Acid value was determined by using the ASTM D974. The acid value of the biodiesel synthesized was 1.4 ± 0.25 mg KOH/g (Table 2). The ASTM biodiesel standard D6751 approved a maximum acid value for biodiesel of 0.5mg KOH/ g which was accomplished by the produced biodiesel.

The copper strip corrosion test of produced Jatropha biodiesel was measured using a standard test specified by ASTM D130. The copper strip corrosion property of the produced biodiesel was found to be within the specification of ASTM.

The kinematic viscosity of the crud oil decreased about 85% after transesterification and amounts 5.14 mm^2/s, this is in the limits of ASTM standards. Through this reduction the flow ability of the crude oil increased in a great extent.

CONCLUSION

It can concluded that Jatropha biodiesel is an acceptable and suitable for diesel fuel. As the Jatropha crop has very good potential to be grown in North Karnataka, therefore it is recommended that it should be produced non-conventional oil that can be transmethylated into an acceptable biodiesel.

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