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Evaluation of Various Fuel Properties of Simarouba Glauca, Custard Apple and Butea monosperma Fatty Acid Methyl Ester

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Abstract**—**. Day by day depletion of liquid fossil fuels creates necessity to find out an alternative liquid fuel like biodiesel. This paper deals with the production of methyl esters from Yellow Oleander oil, Custard Apple oil and Butea monosperma oil by transesterification process using heterogeneous catalyst and methanol as the alcohol. The important properties of Methyl esters such as cloud point, pour point, ash content and carbon residue are tested and compared with other biodiesels. Methyl esters are blended with diesel in different proportions and testing the physicochemical properties such as viscosity, flash point and density for each blended biodiesel.

Keywords— **Simarouba Glauca, Custard Apple and Butea monosperma oil Methyl Esters, Transesterification, Viscosity, Flash Point, Density, Calorific value, Cloud Point, Pour Point, Ash content and Carbon residue.**

Introduction

Day by day fossil fuel resources deplete due to rapidly increasing population and industrialization all around the world. It is important to search for an alternate low-cost fuel for every day usage, which should be sustainable and also friendly to the environment. Biodiesel is considered as a promising alternative fuel because of its reduction of most exhaust emissions, improved lubricity, higher flash point, improved biodegradability and reduced toxicity over conventional diesel fuel [1]The most widely used method of production of biodiesel is Transesterification Process using catalyst. The process of converting triglyceride to fatty acid esters in presence of alcohol and catalyst is called Transesterification. Heterogeneous base catalyst process is noncorrosive, environmental friendly, easy separation and fewer disposal problems [2]. Calcium oxide activated with ammonium carbonate followed by calcination will improve the base strength and performance of catalyst which leads to high yield transesterification reaction [3]. The yield of biodiesel using CaO as a catalyst increases with increase in the temperature and methanol/oil molar ratio, especially in the case of the methanol supercritical state [4, 5]. Simarouba belongs to the family Simaroubaceae Quasia. It had also been known as Paradise tree, Laxmi Taru, Acetuno a multipurpose tree that can grow well under a wide range of hostile ecological condition. Its origin is native to North America, now found in different regions of India. Its seed contains about 40% kernel and kernel content 50-55% oil [2]. Custard apple belongs to the family Annonaceae with botanical name Annona squamosa, is commonly found in deciduous forests, also cultivated in wild in various parts of India. It had also been known as sweetsop and sugar apple (English), seetaaphala and amritaphala (Kannada), Atoa and shariffa (Hindi) [3]. Buteamonosperma belongs to a fabaceae family and tree is native to South Asian Peninsula [4, 5], Burma, Indian subcontinent and Ceylon [6]. It is a slow growing tree that reaches a height of 40 to 50 feet. All parts of the trees widely used in unani, homeopathic and ayurvedic medicine. The B. monosperma seed contains 23% of oil and had significant fungicidal and bactericidal effects.

I. Methodology

Materials: Simarouba Glauca, Custard Apple, B. monosperma Calcium Oxide and Methanol were used in the production of biodiesel. The extraction of oil from the seeds has done by Mechanical expeller.

Transesterification and Separation

The transesterification of Simarouba, Custard Apple, B. monosperma oil with methanol was carried out in a 2000ml three-neck round bottom flask equipped with a water-cooled condenser, a magnetic stirrer and a thermometer. 500ml of oil is taken in round bottom flask and it is heated to 60°C before adding the mixture of methanol and catalyst. The methanol to oil molar ratio is 9:1 and Catalyst of 1.5%wt/v is taken. The whole mixture is maintained at 60°C and continuously stirred using magnetic stirrer for 2 hours. After transesterification, the mixture is allowed to settle in separating funnel for one day. After settling of products into different layers, biodiesel and catalyst is separated.

II. . RESULTS AND DISCUSSION

A. Fuel Properties

Table1: COMPARISON OF FUEL PROPERTIES OF VARIOUS BIODIESEL

Sl. No.	Properties	Standard	Biodiesel Range	Experimental values		
				SOME	CAME	BMME
1	Kinematic Viscosity (Cst) at 40°C	ASTM D445	1.9-6.0	4.7	5.7	4.8
2	Flash point (°C)	ASTM D93	>130	151	150	142
3	Density (Kg/m^3)	ASTM D4052	870-900	875	870	889
4	Calorific Value (MJ/Kg)	ASTM D240	-	37.93	37.51	37.92
5	Cloud point, °C	IS:1448 (P 10)	-3 to 12	19	2	4
6	Pour point, °C	IS: 1448 (P 10)	-15 to 10	15	5	12
7	Ash, %w/w	IS:1448 (P 4)	0.5max	-	Nil	0.003
8	Carbon residue %w/w	IS:1448 (P 8)	0.05max	-	Nil	0.08

ASTM=American Society for Testing and Materials, SOME=Simarouba Oil Methyl Ester,
CAME= Custard Apple Methyl Ester, BMME= Butea monosperma Methyl Ester

B. Kinametic Viscosity

Table 2 shows Kinematic Viscosity of blends of Simarouba, Custard apple and Butea monosperma biodiesel with diesel. Viscosity keeps on increasing with increasing blends. After the test of viscosity, range for biodiesel and its different blends is found to be matching with B10 and can be used in C.I. Engine

TABLE 2. KINEMATIC VISCOSITY OF BLENDS OF SIMAROUBA, CUSTARD APPLE AND BUTEA MONOSPERMA BIODIESEL WITH DIESEL

Properties	Kinematic Viscosity (cSt) at 40°C		
	SOME	CAME	BMME
Diesel	2.5	2.5	2.5
B10	2.7	2.7	2.6
B20	2.8	2.9	2.8
B30	3.0	3.3	3.1
B40	3.3	3.5	3.4
B100	4.7	5.7	4.8

C. Flash point

Flash point keeps on increasing with blends. For Simarouba, Custard apple and Butea monosperma biodiesel as per ASTM specifications it should be greater than 130°C. Since the flash point of biodiesel is very high compared to diesel engine specification range, the biodiesel is blended suitably with diesel to achieve the value of flash point closed to Diesel. It was observed from the table 3, all the biodiesel and its blends are suitable to use in C.I engine.

TABLE 3. FLASH POINT OF BLENDS OF SIMAROUBA, CUSTARD APPLE AND BUTEA MONOSPERMA BIODIESEL WITH DIESEL

Properties	Flash point (°C)		
	SOME	CAME	BMME
Diesel	57	57	57
B10	61	63	64
B20	64	67	70
B30	71	73	71
B40	90	93	90
B100	151	150	142

D. Density

Density keeps on increasing with varying blend proportions due to increase in triglyceride molecules present and higher molecular weights. Density of biodiesel (B100) obtained are very high compared to the suitability in compression ignition (CI) engine, therefore it is also evident that dilution or blending of biodiesel with other fuels like diesel fuel would bring the density close to a specification range. Therefore biodiesel obtained from Simarouba, Custard apple and Butea monosperma was blended with diesel in varying proportions to achieve the required density close to that of a diesel.

TABLE 4. DENSITY OF BLENDS OF SIMAROUBA, CUSTARD APPLE AND BUTEA MONOSPERMA BIODIESEL WITH DIESEL

Properties	Density (Kg/m^3)		
	SOME	CAME	BMME
Diesel	836	836	836
B10	840	841	842
B20	847	844	847
B30	854	850	856
B40	858	854	860
B100	875	870	880

III. . CONCLUSION

- The present investigation evaluates the Calcium Oxide is suitable catalysts for biodiesel production. Calcium oxide catalyst can be recovered and it can be reused.
- The percentage yield of biodiesel is more in Simarouba Glauca oil compared to Custard apple and B. monosperma oil. Kinematic viscosity and Flash point of B. monosperma methyl ester is low compared to custard apple and Simarouba biodiesel.
- The flash point of each biodiesel is high, hence advantage for fuel transportation.
- The Kinematic viscosity, Flash point and Density of obtained biodiesel are high compared to conventional diesel. Hence the biodiesels are blended with diesel in required proportions to reduce the fuel properties to conventional diesel range.

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