Characterization of Biodiesel and It's Blend from the Seed of *Pongamia pinnata (L)* Pierre

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ABSTRACT

The seed of Pongamia pinnata which is popularly known as Karanja in Hindi and Indian beech in English is veritably important available in Assam. The seeds of Pongamia pinnata were acquired from the Assam Engineering College Campus, Jalukbari, Guwahati. The oil from the dried seed of Pongamia pinnata was extracted and then biodiesel, which is a renewable energy, is produced by transesterification method. It is then blended with the petroleum diesel in different ratios and five samples viz. B00, B10, B20, B30 and B100 are prepared. The characterization of biodiesel and its blends were done using different instruments. The determinations of properties of biodiesel, GC –MS analysis, FTIR analysis, CHN analysis, pH value analysis are carried out as parts of characterization of biodiesel. The Gas Chromatography and Mass Spectrometry (GC-MS) are used to identify the various chemical compounds present in the samples. Fourier Transform Infrared (FTIR) analysis is used to determine the functional group present in the samples which confirm the compounds seen in the GC-MS analysis. The percentage of Carbon, Hydrogen and Nitrogen and empirical formula of the samples are determined by the CHN analyzer. The pH values for the samples are also checked.

Keywords:-*Pongamia pinnata*, biodiesel, blends, properties, DC-MS, FTIR, CHN, pH.

INTRODUCTION

Maturity of the world's energy requirements are supplied through petrochemical sources, coal and natural feasts, with the exception of hydroelectricity and nuclear energy. [1] The reactionary energy coffers are abating day by day. Still, these energy coffers arenon-renewable and will be exhausted in the near future.

Biodiesel seem to be a solution for future or effective alternative to diesel [2,3]. *Pongamia pinnata* or karanja or Indian beech is a medium sized glabrous tree with short bole attaining height of around 18-20 meter and its habitat is in the littoral region of south east Asia, Australia [4]. It is adaptable tree for tropical and subtropical regions which requires excellent drainage and sunny location. The leaves are soft, candescent burgundy in summer and develop to a lustrous deep green as the season progress. Small clusters of flowers blossom on branches through the year maturing into brown pods.

The leaves are good source of green manure and being leguminous, they enrich the soil with nitrogen. Seeds are elliptical, reniform, compressed sanguine brown, fairly hard and 2-3 cm long. The seed contains 12.5% to 28.0% of oil, which has been identified as a good source for bio-fuel[5]. Its oil is a source of biodiesel. Pongamia pinnata plant in Assam

Engineering College Campus, Guwahati has studied for its parcels of biodiesel and composites of biodiesel with the petro-diesel.

The production of biodiesel from any fat or oil through a process is called transesterification. Transesterification or alcoholysis is the relegation of alcohol from an ester by another alcohol in a process analogous to hydrolysis, except that alcohol is used rather of water. In the production of biodiesel, oil and fats are transesterified with methanol in the presence of an acid, base or enzyme (lipase) catalyst to afford fatty acid methyl esters (FAME) and glycerol as a by-product [6,7].

The physicochemical properties of frying oil based biodiesel were also analyzed to ensure the product could meet the standards of fuel properties[8]. It has also alternative source of energy, which is renewable, safe and non-pollutant.

TRANSESTERIFICATION

Biodiesel consists of alkyl esters of long chain fatty acids, more commonly methyl esters and is typically made from non-toxic, biological resources such as vegetable oils, animal fats or even used cooking oils. Here, the seed oil from the pongamia pinnata is transesterified to fatty acid methyl esters (biodiesel) mixing with methanol (CH_3OH, 5ml/g of oil) and using K_2CO_3 catalyst (5 wt% of oil) is mechanically stirred at room temperature (32^{o}C).

After completion of the reaction, the product mixture is partitioned between petroleum ether and water by adding petroleum ether and brine solution (10% of NaCl solution). The organic phase that is upper layer is then collected. The collected solution is then dried over anhydrous Na_2SO_4 and the solvent is removed under vacuum to yield the product [9].

CHARACTERIZATION OF BIODIESEL

The koroch oil is extracted from the seed of koroch using the petroleum ether solvent and then the biodiesel of the oil is produced by transesterification of the oil using the solvent and etc. The characterization of the various properties of the koroch oil and the sample from biodiesel and its blends were discussed in the following sections.

CHN ANALYSIS

The physical properties and the chemical properties of the biodiesel from the seed of pongamia pinnata and its blends and the diesel were evaluated and comparative studies of these five samples are performed. The CHN analysis or elemental analysis of any fuel is used to investigate the samples in quantitative and qualitative manner. Element presents in the sample is determine by the qualitative analysis and the percentage of the elements in the sample is determine with the help of the quantitative analysis.

The percentage of Carbon, Hydrogen and Nitrogen are determined by the CHN analyser and the remaining percentage of the sample is the percentage of the Oxygen[10-13]. The empirical formula of the samples is determined after getting the percentage of the carbon, hydrogen and oxygen and the characteristics of the samples.

The results obtained from the elemental analysis are shown in the table. The calorific value of the biodiesel and its blends show that the sample B10 has the highest calorific value as the carbon content of this sample is highest and the oxygen content of this sample is lowest (Table -1).

Table 1:-*CHN analysis of Biodiesel and its Blends*

Sl No.	Particulars	B00	B10	B20	B30	B100
1	Carbon (%)	81.65	83.13	80.79	77.43	71.96
2	Hydrogen (%)	12.55	12.79	12.48	12.11	11.51
3	Nitrogen (%)	0	0	0.20	0	0
4	Oxygen (calculated)	5.80	4.08	6.53	10.46	16.53
5	Calorific value (MJ/kg)	43.5	42.7	41.9	41.0	35.9
6	H/C ratio	1.82	1.83	1.84	1.87	1.91
7	O/C ratio	0.05	0.04	0.06	0.10	0.17
8	Empirical formula	$C_{18.9}H_{34.5}O$	$C_{26.6}H_{48.7}O$	$C_{16.4}H_{30.2}O$	$C_{9.9}H_{18.5}O$	$C_{5.8}H_{11.1}O$

pH Value

The acidity or basicity (alkalinity) of any liquid is determined in reference to the pH value of that liquid.

The pH values for the samples are determined in the Civil Engineering Department, Bineswar Brahma Engineering College, Kokrajhar and the results of the samples B00, B10, B20, B30, B100 were tabulated as below. As the range of the samples are from 7 to 9.4, the samples are basic in nature since the liquid with pH value less than 7 is the acidic and more than 7 it is basic.

The pH values of the biodiesel and its blends represent the basic in nature that's why these fuels were directly useable to compression ignition engines as shown in Table 2.

Table 2:-*pH value of the samples*

Particular	B00	B10	B20	B30	B100
pH	7.05	9.4	8.2	7.5	7.1

GC-MS Analysis

This analysis is used to determine the major compounds and the chemical structure in the samples of biodiesel, blends of biodiesel-diesel and diesel.

The results of the GC-MS analysis in the five samples are represented with the help of GC-MS chromatograms in the Figure 1-5 which gives the chemical compounds, molecular weight and the respective formula of the samples.

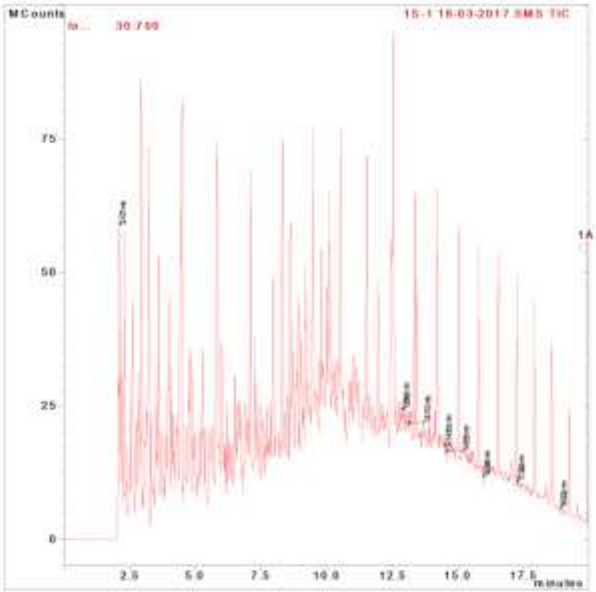	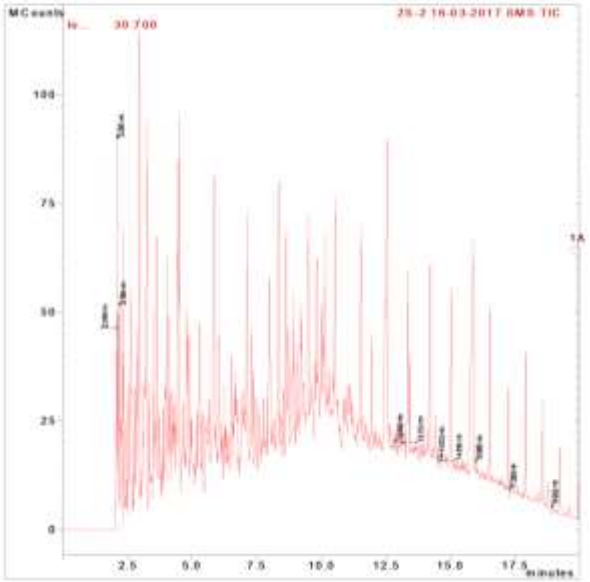
***Fig.1:**-GC-MS spectrum of diesel*	***Fig.2:**-GC-MS spectrum of sample B10*
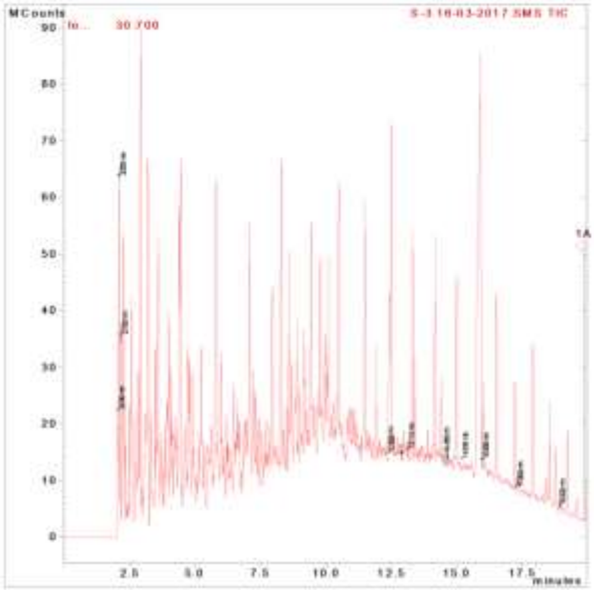	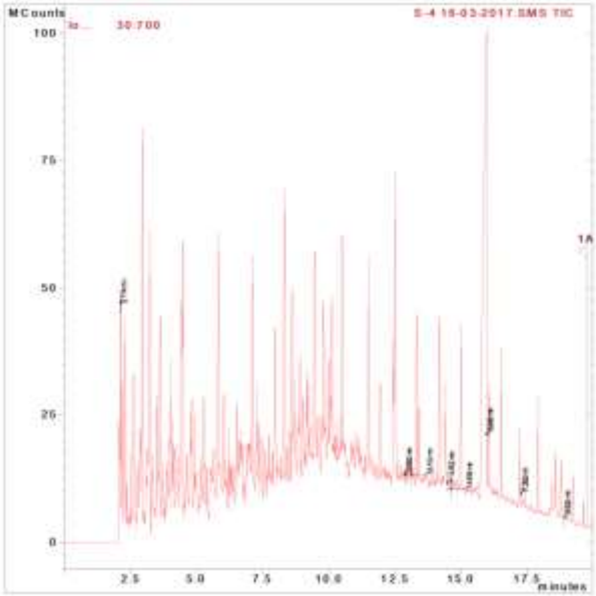
***Fig.3:**-GC-MS spectrum of sample B20*	***Fig.4:**-GC-MS spectrum of sample B30*

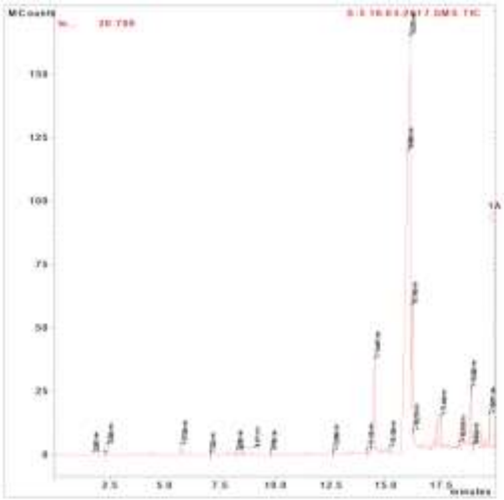

Fig.5:*-GC-MS spectrum of sample B100*

FTIR ANALYSIS

The functional group and structure of the compounds present in the samples are found from the shape, position and intensity of the peaks in the FTIR spectrum. The functional groups identified from the peaks observed in FTIR spectrum are confirmed the compounds detected in GC-MS analysis[14]. The IR spectrums of the samples are given in the Figure 6 to 10.The FTIR spectrum of diesel in Figure 6 shows the strong and sharp signals at 2926 and 2856 cm^{-1} are due to C-H stretching frequencies. The signals at 1457 and 1377 cm^{-1} may be due to $–CH_2$- and $–CH_3$ bending.

The FTIR spectrum of B10 in Figure 7 shows a signal at 1748 cm^{-1} is due to C=O stretching frequency of methyl esters (RCOOMe) and signal at 1024 cm^{-1} may be due to C-O stretching frequency. The signals at 1456 and 1378 cm^{-1} may be due to $–CH_2$- and $–CH_3$ bending. Strong and sharp signals at 2922 and 2854 cm^{-1} are due to C-H stretching frequencies. In the FTIR spectrum of B20 in Figure 8 shows a sharp signal at 1747 cm^{-1} is due to C=O stretching frequency of methyl esters (RCOOMe) and signals at 1165 and 1019 cm^{-1} may be due to C-O stretching frequencies. The signals at 1456 and 1377 cm^{-1} may be due to $–CH_2$- and $–CH_3$ bending. Strong and sharp signals at 2923 and 2855 cm^{-1} are due to C-H stretching frequencies.

In the FTIR spectrum of B30 in Figure 9 shows a sharp signal at 1747 cm^{-1} is due to C=O stretching frequency of methyl esters (RCOOMe) and signals at 1163 and 1021 cm^{-1} may be due to C-O stretching frequencies. The signals at 1460 and 1378 cm^{-1} may be due to $–CH_2$- and $–CH_3$ bending. Strong and sharp signals at 2925 and 2855 cm^{-1} are due to C-H stretching frequencies. In the FTIR spectrum of B100 in Figure 10 shows IR spectrum of biodiesel showed a C=O stretching band of methyl esters (RCOOMe) at 1747 cm^{-1} and C-O stretching bands at 1173 and 1023 cm^{-1}. The weak signal at 1646 cm^{-1} is due to C=C stretching frequency. The signals at 1464 and 1377 cm^{-1} may be due to $–CH_2$- and $–CH_3$ bending. The observation of an absorption peak at 723 cm^{-1} suggested the CH_2 rocking. Strong and sharp signals at 2924 and 2856 cm^{-1} are due to C-H stretching frequencies. The weak signal at 3451 cm^{-1} may be due to O-H stretching frequency of water.

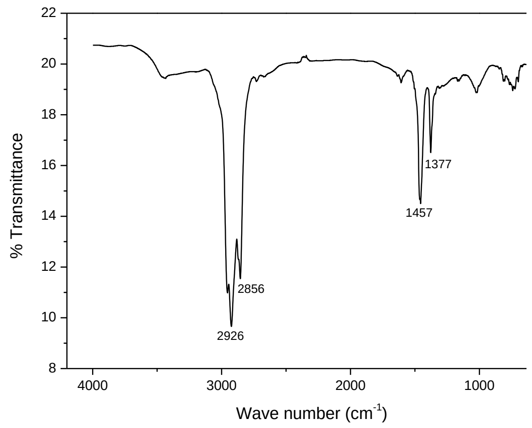

***Fig.6:**-FTIR of Diesel (B00)*

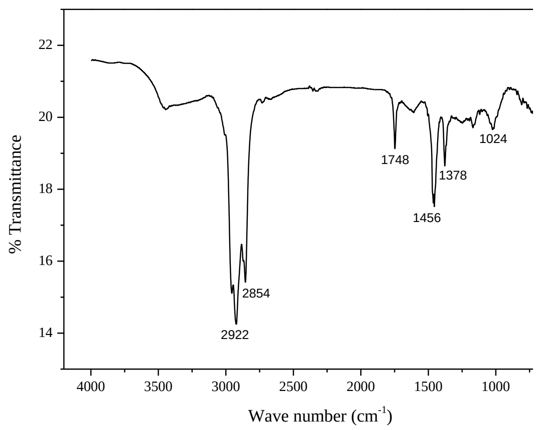

***Fig.7:**-FTIR of Biodiesel and its blend (B10)*

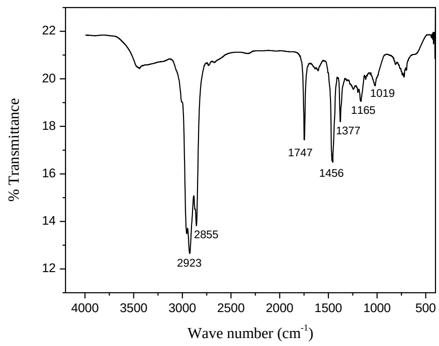

***Fig.8:**-FTIR of Biodiesel and its blend (B20)*

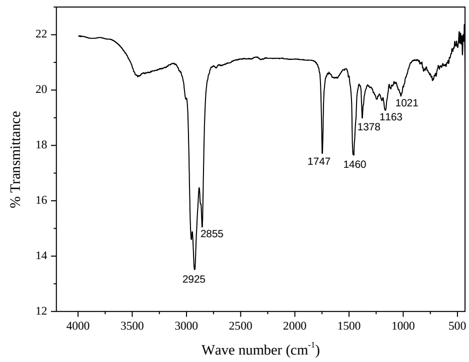

***Fig.9:**-FTIR of Biodiesel and its blend (B30)*

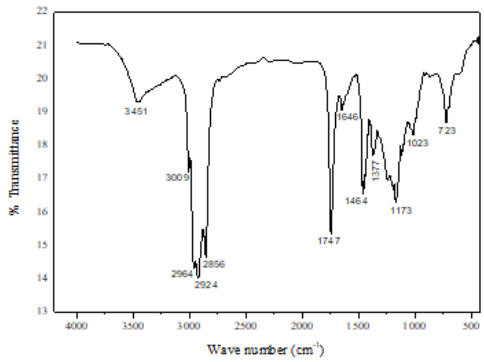

***Fig.10:**-FTIR of Biodiesel (B100)*

CONCLUSION

In the characterization of biodiesel and its blend from the seed of *Pongamia pinnata (L) Pirrei*, the different character of the biodiesel and its blends were discussed through CHN analyser, pH value, GC-MS, and FTIR. The percentage of Carbon, Hydrogen and Nitrogen and empirical formula of the samples are determined by the CHN analyser. The calorific value of the biodiesel and its blends show that the sample B10 has the highest calorific value as the carbon content of this sample is highest and the oxygen content of this sample is lowest. The pH values for the samples are also checked. The pH values of the biodiesel and its blends represent the basic in nature that's why these fuels were directly useable to compression ignition engines. The Gas Chromatography and Mass Spectrometry (GC-MS) are used to identify the various chemical compounds present in the samples like chemical compounds, molecular weight and the respective formula of the samples. Fourier Transform Infrared (FTIR) analysis is used to determine the functional group present in the samples which confirm the compounds seen in the GC-MS analysis.

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