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Fatty Acid Methyl Esters Characteristic and Esterification of Some Vegetable Oils for Production of Biodiesel

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Abstract: *Biodiesel is a cleaner burning fuel than diesel and a suitable replacement. It is made from non-toxic, biodegradable, renewable resources, such as new and used cooking oil and non edible oil. In this study oil sources were obtained from the seeds of Ricinus commonis, Cocos nucifera, Brassica juncea, Arecaceae elaels, Helianthus annus Linn, Madhuca longifolia and Pongamia pinnata oils. Biofuel Characteristics such as free fatty acid content, Iodine value, saponification value, cetane number, energy value and density were studied. Productions of Fatty Acid Methyl Ester by Transesterification of oil samples were recovered. The results validate that all these samples are can used as sources for biodiesel production.*

Key Words: *Biodiesel, saponification value, cetane number, Transesterification.*

I. Introduction

All countries including India are grappling with the problem of meeting the ever increasing demand of transport fuel within the constraints of international commitments, environmental concerns and limited resources. The growth in energy demand in all form is expected to continue unabated owing to increasing urbanization, standard of living and expanding population. The increasing gap between the demand and production of petroleum based energy resource is a matter of serious concern. India ranks sixth in the world in terms of energy resource are a matter of serious concern. India ranks sixth in the world in terms of energy demand accounting for 3.5% of the world's commercial energy demand in 2001. The energy demand is expected to grow at 4.8%. In additional local pollution and poor air quality are becoming serious as the use of fossil fuel increases. However, inexpensive bio fuel is a clean substitute for expensive fossil fuel imports (1). Biodiesel is a vegetable oil methyl ester and if is usually produced by a transesterification and esterification reaction of vegetable or waste oil respectively with a low molecular weight alcohol, such as ethanol and methanol. India has vast resources of oil seeds from which oil can be derived to develop biodiesel depending upon the potential of specific seed in the locality. Experiments have shown that the biodiesel derived from the oil seeds can be used in existing design of diesel vehicles without any sustained modification (2).

Biodiesel produced from vegetable oil is a good substitute or additive fuel for diesel fuel. The main commodity sources for biodiesel in India can be non-edible oil obtained from plant species such as *Jatropa curcas, Pongamia pinnata, Calophyllum inophyllum* and *Hevea brasiliensis*. In the present study various characters such as Free Fatty Acid (FFA), Iodine Value (IV), Saponification Value (SV), Cetane Number (CN), Calorific Value (CV) and Density character have been assessed in the oil such as *Ricinus commonis, Cocos nucifera, Brassica juncea, Arecaceae elaels, Helianthus annus* Linn, *Madhuca longifolia, Pongamia pinnata* oils.

II. Materials And Methods

Oil samples were collected and analyzed parameters. Free fatty acids, iodine value, calorific value, determination of density, saponification value were estimate by the method of Manikam and Sadasivam (3). Transesterification were estimated by direct method of Jarpan (4).

cetane number calculated by following equation.

$$\text{cetane number} = 46.3 + 5458/sn - 0.225 \times iv$$

where,

sn = Saponification value of sample.
iv = Iodine value of sample.

III. Results And Discussion

A small quantity of free fatty acids is usually present in oils along with triglycerides. The free fatty acids content is known as acid number or acid value. The highest acid value in this study was 16.92% in *Arecaceae Elaels* and the lowest was 1.41% in *Pongamia pinnata* (Fig no: 2).

Vegetable oils have a wide variety of fatty acid composition, depending on their source. Among the fatty acids, oleic acid is particularly stable to thermal oxidation because it only contains one double bond in its molecular structure although most sunflower oils have about 20% of oleic acid, high breed varieties may reach 80% content, so this oil has been a special interest in the synthesis of esters used as bio-fuels and lubricants (5).

The iodine value is the measure of degree of unsaturation in oil. It is constant for particular oil or fat. Iodine value is a useful parameter in studying oxidative rancidity and chemical stability properties of different oil and biodiesel fuels. Higher quantity of double bonds in the sample has greater potential to polymerise and hence lesser stability. The maximum iodine value in this study was 100.88 in oil *Brassica juncea* and the lowest was 9 in *Cocos nucifera*. IV of *Ximenia americana* oil 76.3 (6), *Argemone mexicana* oil 128.0, *Michelia champaca* oil 104.0, *Euonymus hamiltonianuis* oil 96.3 (7), *Momordica dioica* oil 174.0 and *Balanites roxburghii Planch* oil 109.9 (8).

Saponification is the process by which the fatty acids in the glycerides of oil are hydrolyzed by an alkali. Saponification value in the amount (mg) of alkali required to saponify a definite quantity (gm) of an oil or fat. This value is useful for a comparative study of the fatty acid chain length in oils. The maximum Saponification value in this study was 252 in *Cocos nucifera* and the lowest was 172.504 in *Brassica juncea* (Fig no: 3). Saponification value of *Ximenia americana* Linn oil is 169.2, *Momordica dioica* Rox 189.5, *Balanites roxburghii planch* 188.9 and *Mimusops hexendra* 202.0 (9).

CN number is the ability of fuel to ignite quickly after fuel injected. Higher its value, the better emission of fuel, this is one of the important parameters which is considered during the selection of FAMEs for use as biodiesel. CN number is a relative measure of interval between the beginning of injection and auto ignition of the fuel. Fuels with low CN number will result in difficult starting, noise, and exhaust smoke. In general, diesel engines will operate better on fuels with CN above 50. In this study showed CN value between 52 and 66. Adams and Miovic (8) calculated CN in *Schleichera oleosa* Oken 61.55, *Tectona grandis* Linn 48.31, *Argemone mexicana* 44.4 and *Michelia champaca* Linn 50.28 oil samples (Fig no: 1).

Historically, the first CN tests were carried out on palm oil ethyl esters which had a high CN. A result confirmed by later studies on many other vegetable oil-based diesel fuels (10 & 11).

Heating value or heat of combustion is the amount of heating energy released by the combustion of a unit value of fuels. In this study, the heating value of oil samples was varying from 9332.38 - 59180.44 kj/kg, which is agreement in the others samples tested. Energy values have been reported in other samples such as Rapseed oil-35000kj/kg, Linseed -39307kj/kg, soybean -39623kj/kg, Tallow -40054kj/kg (11). Density is the weight per unit volume. Oils that are denser contain more energy. This study showed highest density in *Madhuca longifolia*, *Pongamia pinnata* and *Arecaceae elaels*.

Transesterification refers to a reaction between an ester of one alcohol and a second alcohol to form an ester of the second alcohol and an alcohol from the original ester, as that of methyl acetate and ethyl alcohol to form ethyl acetate. During transesterification oil or fat reacts with an alcohol which is typically methanol in the presence of a base catalyst, such as sodium hydroxide. The transesterification yields two products, Fatty acid Methyl Ester [FAME] as a biodiesel and glycerin. *Cocos nucifera*, *Brassica juncea*, *Helianthus annus* Linn, *Madhuca longifolia* and *Pongamia pinnata* produced above 84% of FAME by Transesterification (Fig no: 4).

Biodiesel has similar physical properties, the emissions from biodiesel are much better for the environment. Biodiesel, when used in a conventional diesel engine results in substantial reductions of unburned hydrocarbons, carbon monoxide and particulate matter compared to diesel fuel. Also the emission of sulfur oxides and sulfates (the major components of acid rain) from biodiesel are essentially eliminated compared to diesel. A 1998 biodiesel lifecycle study, sponsored by the US Department of Energy and the US Department of Agriculture found that biodiesel reduces carbon dioxide emissions by 78% compared to petroleum diesel. The CO2 that is released can be recycled by growing plants which are later processed for this fuel.

1. FIGURES

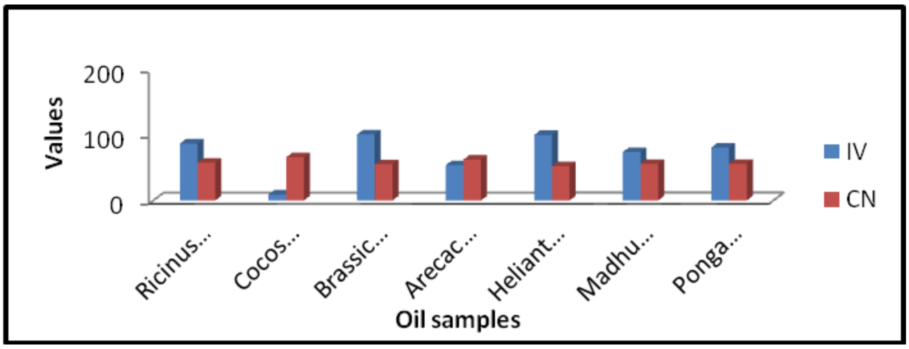

Figure no 1: Iodine value and Cetane number of oil samples

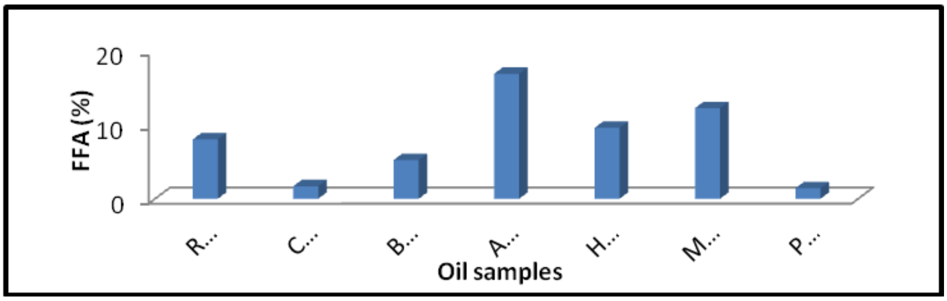

Figure no 2: Fatty Acid Percentage of oil samples

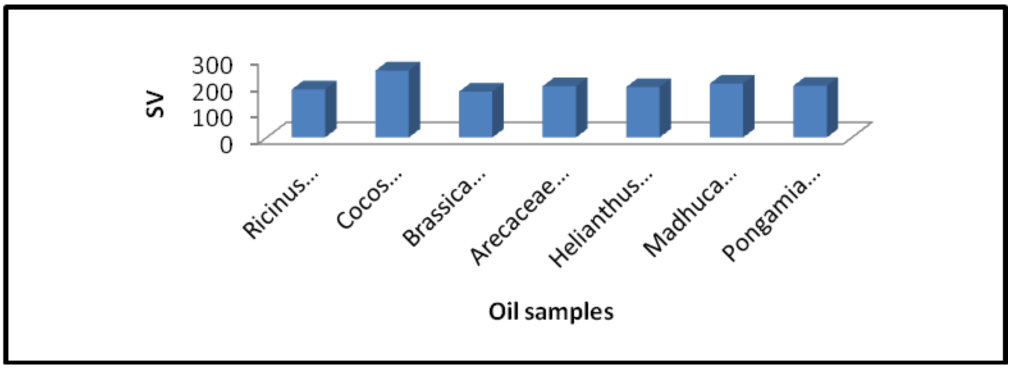

Figure no 3: Saponification value of oil samples

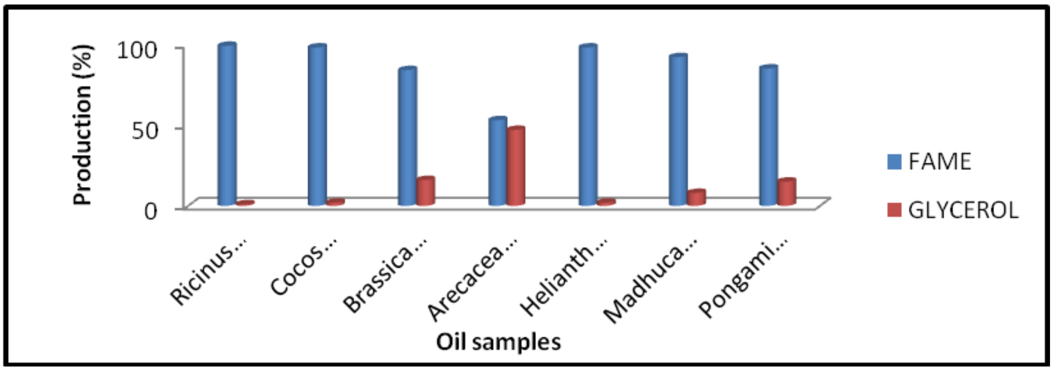

Figure no 4: Production of FAME by Transesterification of oil samples

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