

## Research Article



## ***Madhuca indica* J.F. Gmel. [MAHUA] an Alternative Source for Biodiesel Industrial of Future**

V.N Ariharan\*<sup>1</sup>, V.N Meena Devi<sup>2</sup>, N.K.Pameswaran<sup>1</sup>, P. Nagendra Prasad<sup>1</sup>

<sup>1</sup>Dept of Biomedical Engg, Noorul Islam Centre for Higher Education, Noorul Islam University, Kumaracoil, Thuckalay Tamilnadu, India.

<sup>2</sup>Dept of Physics, Noorul Islam Centre for Higher Education, Noorul Islam University, Kumaracoil, Thuckalay, Tamilnadu, India.

\*Corresponding author's E-mail: [kabilvn@gmail.com](mailto:kabilvn@gmail.com)

Accepted on: 31-05-2015; Finalized on: 31-07-2015.

### ABSTRACT

The biodiesel has the power to harmonize sustainable development, energy conservation, management, efficiency and environmental preservation. In India there are many potential petro crops are available in nature and *Madhuca* is one among them. Its botanical name is *Madhuca indica*. It is a tree which can be raised from seed or stem cuttings. It thrives well in dry tropical and sub-tropical climates. The tree can withstand drought and are often found in inaccessible places. The Physico-Chemical Properties of the oil was analyzed by blending with conventional diesel at 10% (B10) and 20% (B20) proportions. The general properties assessed in the physical parameters include, Density Viscosity, Specific gravity, Salinity, Conductivity, pH, Total dissolved oxygen and Total dissolved solid. The significant biodiesel characters like flash point, fire point, smoke point, pour point, cloud point and carbon residue and ultrasonic characters like ultrasonic velocity, adiabatic compressibility, acoustic impedance, relaxation time were also assessed. The chemical parameters estimated such as Acid value, Iodine value and Saponification value, Average molecular weight and Cetane number. The values were compared with the ASTM standards of biodiesel. The property of B20 biodiesel is found to be within the ASTM standard and it can serve as a potential source for biodiesel industrial of future.

**Keywords:** *Madhuca indica*, Ultrasonic, Acoustic impedance, ASTM Standard.

### INTRODUCTION

**M**ahua [*Madhuca indica* J.F. Gmel.] is a large tree belongs to the Family Sapoteceae.<sup>1</sup> It is commonly known as Illupai in Tamil. *Madhuca* or Butter nut in English. Mahua or Mahwa in Hindi. *Madhuka*, *Madhudruma* (honey tree), *Madhupushpa* (honey flower), *Madhusakha*, *Gudapushpa* (sugar flower) in Sanskrit.<sup>2</sup> Several parts of the tree like Flowers, Fruits, Seeds and Oil are used as medicine for human ailments.<sup>3</sup> As the flower are more sweetened and it is used as sweetening agent in lieu of cane sugar. The flowers are rich in sugar [73%] and next to cane molasses. The fresh flowers are delicious, and are consumed.<sup>4</sup> There is a saying in Tamil "*aalai illaa oorukku iluppaip poo charkkarai*". The flowers are used to make liquor and vinegar in tropical India. The seeds yield a fat known as *Madhuca* butter, which is used in cooking, adulteration of Ghee, manufacturing chocolates and even soaps, besides treatment of Rheumatism, Piles, Hemorrhoids, and constipation.<sup>5</sup> Tribal's used this oil an illuminant and hair fixer. Mahua cake is insecticidal and also used as organic manure. As a tree its seeds and flowers have very useful in Indian Economy for a long period.<sup>6</sup> The tree blooms from February to April. It grows to a height of 20 m. The timber is useful for manufacturing household article.<sup>7</sup> Fresh oil is yellow in color, while commercial oil is generally greenish yellow with disagreeable odor and taste.<sup>8</sup> The annual production of the *madhuca* oil is about 60 million tons per annum in India.<sup>9</sup> As this tree grows mainly in forest area in Western Ghats and in Central North Indian plains, in waste lands and fallow lands. It is adapted to arid environments, being a prominent tree in

tropical mixed deciduous forest in India.<sup>10</sup> It commonly occurs in West Bengal, Sathisgar, Jharkhand, Uttarpradesh, Bihar, Telangana, Mathyapradesh, Gujarat, Orissa, Kerala and Tamilnadu.<sup>11</sup> Its cultivation would not produce any impact on food production but would in long way improve the environmental condition by massive afforestation.<sup>12</sup> Recently researchers are engaged in screening of the vegetable oil to find out the potentiality of the biodiesel.<sup>13,14</sup> In the present study the direct blending of *Madhuca* oil with petro diesel at two different proportions of 10 % and 20% (B10, B20) were analyzed for its physico chemical properties of biodiesel to ascertain its use as natural source of energy.

### MATERIALS AND METHODS

#### Collection

The *Madhuca indica* seeds were collected from Courtrallum Forest region of Thirunelveli District, Tamil Nadu, India. The diesel used for the experiment was purchased at Indian Oil Corporation, Thuckalay, Tamilnadu, India.

#### Extraction

The seed were dried, dehulled and the impurities were removed by hand picking. The kernels were crushed by using a laboratory mortar and pestle. The oil was extracted by using Soxhlet apparatus with the solvent Petroleum ether for 48 hours.

#### Blend preparation

The blends were made on a volume basis and stored in glass bottles at room temperature. A blend of 20%



biodiesel with 80% conventional petroleum diesel, by volume, is termed "B20" and a blend of 10% biodiesel with 90% conventional petroleum diesel, by volume, is termed "B10". The Physico Chemical studies were carried out for the blends of biodiesel.

### Physico-Chemical Analysis

Madhuca Indica oil blends (B10 and B20) were analyzed for various physical and chemical properties. The general physical parameters, the specific gravity and density were measured by using Brosil glass bottle method. Viscosity was measured by using calibrated Ostwald Viscometer. The pH was determined by using Elico pH meter. The fire point was analyzed by using Cleveland open cup apparatus. The flash point was determined by using Pensky-Martens closed cup tester apparatus. The cloud point was obtained by using Deep vision Cloud point apparatus. The pour point was analyzed by using Deep vision Pour point apparatus. The Smoke point was observed by using set a Smoke point apparatus. Carbon residue was determined by using Conradson Carbon residue apparatus. The Ultrasonic studies were carried out by using Ultrasonic interferometer (Mittal & Co.) with a frequency of about 3 MHz. The econometric constant namely the Iodine value was determined by Wijs method. The acidimetric namely acid value and saponification value were measured by the standard AOAC method. The average Molecular weight and Cetane number were obtained from ultrasonic parameters.

### RESULTS AND DISCUSSION

**Table 1:** A General Physical property of Madhuca Indica oil blends B10, B20 and diesel

Parameters	Madhuca Indica Oil Blends		Diesel
	B10	B20	
Density (g/ml)	1.2204	1.2328	0.804g/cm <sup>3</sup>
Viscosity (Nm-2s)	3.900	4.250	3.5
Specific Gravity	0.9130	0.8348	0.880
Conductivity (μs)	0.62	0.62	0.00
Salinity (ppt)	0.00	0.00	0.00
pH	3.53	4.56	6.8
Total dissolved solid (ppm)	0.26	0.26	0.00
Total dissolved oxygen (ppm)	8.7	8.9	0.00

The oil content of the dried seed of Madhuca Indica is about 40% on dry weight basis. The general Physical properties of Madhuca Indica oil such as Density, Viscosity, Specific gravity, pH, Total dissolved solid, Total dissolved oxygen were measured for the biodiesel blends at 10%, 20% proportions.

The results were given in Table-1. The Significant physical properties of the oil such as fire point, flash point, Cloud

point, Pour point, Smoke point, Carbon residue were measured for blends of 10% and 20% proportions. The results were given in the Table-2. The Ultrasonic characters like ultrasonic velocity, adiabatic compressibility, acoustic impedance, relaxation time of the Madhuca Indica were measured for blends of 10% and 20%. The results were given in the Table-3. The Chemical properties of the oil such as Acid value, Iodine value and Saponification, Average molecular weight, Cetane number were presented in the Table-4.

Higher Density and Viscosity of the liquid fuels affects the flow properties of the fuel, such as spray automation, subsequent vaporization and air-fuel mixing in the compression chamber. The change in spray can greatly alter the compression properties of the fuel mixture. The Specific gravity, Density and viscosity of vegetable oil are several times higher than that of diesel. By mixing the vegetable oil with the conventional diesel with 10% and 20% the Specific gravity, Density and Viscosity were found to slightly higher than that of diesel and it is within the range of the ASTM standard value of the biodiesel. The specific gravity is important when considering the spray characteristic of the fuel within the engine. The pH of biodiesel blends are slightly less than the petro diesel which also indicates the biodiesel is more acidic than the conventional diesel due to the presence of fatty acid. The fire point of the blends B10 and B20 are almost equal and the B20 is slightly higher than that of petro diesel, and which falls within the range of ASTM standard. The flash point of these B10 and B20 are almost equal to the petro diesel and the values are within the range specified for petro diesel. The flash point of the biodiesel is higher than that of fossil fuel, so it clearly indicated that biodiesel is safer to handle than fossil fuel. The cloud point and pour point is slightly higher than the petro diesel, because of the fatty acids and the nature of fatty acids present in the biodiesel blends. The Smoke points of the biodiesel blend are less than the petro diesel but within the ASTM standard value. The carbon residue is slightly higher than the petro diesel. The high value of carbon residue may be due to the impurities present in the biodiesel blends.

The acid value of blends indicates that the amount of fatty acid present in the sample. The Acid value is slightly higher than that of ASTM standard because of the presence of the long chain unsaturated fatty acid in the blends. The number of double bonds present in the vegetable-oil is calculated by treating with iodine. The higher the iodine number is the amount of iodine needed to be saturate or break the double bonds in the fatty acid. Here the iodine values of biodiesel blends are lesser than the petro diesel and it is within the range of ASTM standard of the biodiesel. The Saponification value can indicate the non-fatty acid impurity and the amount of alkali that could be required by the fat for its conversion to soap. In the biodiesel blends the Saponification values are less than that of the petro diesel. However the Saponification value is found to be within the acceptable-



range of biodiesel. When compared to the petro diesel the average molecular weight is lesser and the Cetane number values are slightly higher.

**Table 2:** Significant Physical properties of Madhuca Indica oil blends B10, B20 and diesel

Parameters	Madhuca Indica Oil Blends		Diesel
	B10	B20	
Fire point	54.8	55.6	54.0°C
Flash point	53.7	48.9	47.2°C
Cloud point	3°C	2°C	3°C
Pour point	2°C	2°C	0°C
Smoke point	9mm	12mm	9mm
Carbon residue	0.14	0.17	0.2g

**Table 3:** Ultrasonic Properties of Madhuca Indica oil blends B10, B20 and diesel

Parameters	Madhuca Indica Oil Blends		Diesel
	B10	B20	
Ultrasonic velocity( $\times 10^6$ m/s)	1.557	1.368	2.180
Adiabatic compressibility ( $\text{kg}^{-2}\text{s}^{-1}$ )	0.416	0.637	0.35
Acoustic impedance ( $\times 10^6\text{kgm}^{-2}\text{s}^{-1}$ )	1.682	1.152	1.55
Relaxation time (secs)	3.818	3.306	3.93

**Table 4:** Chemical Properties of Madhuca Indica oil blends B10, B20 and diesel

Parameters	Madhuca Indica Oil Blends		Diesel
	B10	B20	
Acid value (mg KOH/g)	0.78	0.99	16.31
Iodine value	86.21	96.58	6.84
Saponification value	189.88	200.09	180.41
Average molecular weight	276.75	260.31	279.67
Cetane number	64.71	52.36	50.45

## CONCLUSION

The present study concluded that the kernel of Madhuca indica contains 40 % of fatty acid. The oil extracted from the kernel is used as a bio-fuel. It can be directly blend with the fossil fuel at the maximum of 20%.

The petroleum derived fuels like gasoline and diesel are being used almost by the entire road transport vehicles.

The diesel fuel is also being used in agriculture operations. In recent times the combustion of these fossil fuels has been recognized as a major cause of air pollution. Although CNG and LPG are being promoted as cleaner alternatives but they are in short supply and one has to depend on imports to meet the increased requirements. Uncertain supplies and fluctuations in the

prices of fossil fuels in the international market need a search for renewable, safe and non-polluting sources for the fuel.

Therefore an urgent need for cleaner alternatives which could reduce both the pollution as well as the dependence on imports.

Among various alternatives, biodiesel, a bio-source could be the substitute to diesel.

As well as various parts of the tree is used for immense medicinal properties, as an illuminant and manufacturing of household articles, the growing of more trees reduce the pollution, global warming, and improve the environment.

These multifacious usage and various oil parameters of Madhuca indica oil, a potential source as an oilseed feedstock for biodiesel has honour to establish this untapped resource as alternative source for Bio-Diesel industry of future.

**Acknowledgement:** The authors are thankful to the Department of Science and Technology Govt. of India (DST/TSG/AF/2012/01 dated 31 December 2012) for financial assistance to carry out this investigation. The authors are indebted to the Chancellor, Vice Chancellor and the Management, Noorul Islam University, Kumaracoil for their valuable guidance, constant encouragement and providing basic facilities throughout the study.

## REFERENCES

1. Pankaj Oudhia, Robert E. Paull, Butter tree Madhuca latifolia Roxb. Sapotaceae Encyclopedia of Fruit and Nuts, J. Janick and R. E. Paull editors, CABI, Wallingford, United Kingdom, 2008, 827-828.
2. Shivendra Kumar, Biodiesel from petro – plants, Alive, 270, 2005, 46-47.
3. Ajay Kumar, I S Singh, Chemical evaluation of Mahua ( Madhuca Indica) seed, Journal of food Chemistry, 40(2), 1991, 221-228.
4. Mark Duell, Trunk and disorderly! Herd of 50 drunken elephants ransack village after gulping down 500 LITRES of alcohol in shop. London: Dailymail.co.uk. Retrieved, 2013, 11-21.
5. Bringi N.V, Non-traditional oil seed and oils of India, Oxford and IBH, New Delhi, 1987, 57.
6. D.A.Patil, Mahuwa tree and the aborigines of North Maharashtra, Nisclair.res.in. Retrieved, 2013, 11-21.
7. Elamathi S, Thomas Abraham and Singh S. S., Bio energy hope for the millennium, Agrobios, 3, 2005, 15-16.
8. Product profile, Mahuwa, Trifed, Ministry of Tribal Affairs, Government of India. Trifed.nic.in. Retrieved, 2013, 11-21.
9. Radhakrishna P, Candidates for Bio-diesel and Prospective shareholders to accelerate program specific economic activity, All India seminars on National Policy on Non-conventional energy sources, Renewable Energy Science Series XII.



10. Bhatt Y. C., Murthy N S. and Datta R. K, Use of Mahua Oil (*Madhuca indica*) as a Diesel Fuel Extender, *IE (I) Journal. AG.*, 85, 2004, 10-14.
11. Canakci Mustafa, The potential of restaurant waste lipids as biodiesel feedstocks. *Bioresour. Technol*, 98, 2007, 183–190.
12. Bhupendra Kumar Singh, Energy security and alternative energy, *Alive*, 2006, 10-13.
13. Meena Devi. V.N, Vijayalakshmi G.S. and Nagendra Prasad.P, Ultrasonic studies – a novel method for screening biodiesel, *National Jour. of Life Science*, 2006.
14. Meena Devi. V.N, Vijayalakshmi G.S. and Nagendra Prasad P, *Bassia – A new potential source for Biodiesel*, 34(1), *Geobios*, 2007, 9-11.

**Source of Support: Nil, Conflict of Interest: None.**

