Research Article

Physico Chemical Analysis of *Pongamia pinnata* for Potential Biodiesel Source

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ABSTRACT

The growing demand for fuel and the increasing concern for the environment due to the use of fossil fuel have led to the search of biofuel as a useful alternative and environmentally friendly energy resource. From the time immemorial, plants have been widely used as curative agents for variety of ailments. Concentrated fruits or seeds extract can be found in various herbal preparations which are widely available in market. Nowadays the biomass resources are widely used for the energy purposes. *Pongamia* is one among them which could be used as an energy source. It has been used in India and neighboring regions as a source of traditional medicines. It has been used as animal fodder, green manure, timber, fish poison and fuel. Extract of the plant possess significant anti-diarrhoeal, anti-fungal, anti-plasmodial, anti-ulcerogenic, anti-inflammatory and analgesic activities. The oil obtained from the seeds can be used as biodiesel. It is an alternative source of energy, which is renewable, safe and eco-friendly. In this present study the Physico Chemical properties of the blends of B10 and B20 oils were analyzed and the results were discussed.

Keywords: Pongamia, Fossil Fuel, Biodiesel, Curative Agents.

INTRODUCTION

Pongamia pinnata belongs to the family Fabaceae[1]. It is a medium –sized glabrous tree. It is adaptable tree for tropical and sub-tropical regions which requires excellent drainage and a sunny location. It grows easily from seed[2]. Pongamia is known as Indigenous Beech Pongamia, andHonge in English, Pungam in Tamil, Pongam in Malayalam, Karanja in Hindhi, Kanuga orGanuga in Telungu, Singhdapathra in Sanskrit [3]. The natural distribution of Pongamia is along coasts and river banks in India and Burma. This species is native to the Asian subcontinent and has been introduced to humid tropical lowlands in the Philippines, Malaysia, Australia, the United States and Indonesia[4]. It is native to humid and subtropical environments. Pongamia thrives in areas having an annual rainfall ranging from 500 to 2500 mm and maximum temperature ranges from 27 to 38°C and the minimum 1 to 16^0 C[5]. This species grows to an elevation of 1200 m, but in the Himalayan foothills is not found above 600 m. Pongamia can grow on most soil types ranging from stony to sandy to clay but does not do well on dry sands. Pongamia trees can tolerate drought, frost, heat, limestone, sand, and salinity.

It is highly tolerant of salinity and they will grow under conditions ranging from near 0º C up to over 50º C [6]. It is common along waterways or seashores with its roots in fresh or salt water[7]. The Pongamia is a medium sized evergreen tree with a spreading crown and a short bole, deciduous, sub-evergreen tree that generally attains a height of about 25 m tall and trunk diameter of more than 50 cm. Flowers borne on racemes, are pink, light purple, or white. Flowers are one cm across, zygomorphic, style incurved. The kernels are white and covered by a thin reddish skin. The bark is thin gray to grayish- brown, and yellow on the inside[8]. *Pongamia pinnata*is a preferred species for controlling soil erosion and binding sand dunes because of its dense network of lateral roots. Root, bark, leaves, flower and seeds of this plant also have medicinal properties and traditionally used as medicinal plants[9].

All parts of the plant have been used as crude drug for the treatment of human ailments like tumors, piles, skin diseases, wounds and ulcers [10]. In the traditional system of medicines, such as Ayurveda and Unani, the *Pongamia pinnata* plant is used for anti-inflammatory, anti-plasmodial, anti-nonciceptive, anti-hyperglycamic, anti-lipidperoxidative, anti-diarrhoeal, anti-ulcer, anti-hyperammonic and antioxidant activity [11]. The *Pongamia pinnata*is known for its multipurpose benefits as timber and fuel[12]. Naik et al. 2008 identified as a potential source of biodiesel [13].

It has been recognized as "Biodiesel". Because of the presences of saturated and unsaturated fatty acid composition about 20.5% and 79.4%, respectively. The major mono unsaturated fatty acid was oleic acid (46%) whereas linoleic acid (27.1%) and linolenic acid (6.3%) constitutes the total polyunsaturated fatty acid. Low molecular weight fatty acids such as lauric and capric acids occur in very small amount of about 0.1% each[14,15]. In this present investigation the Physico Chemical analysis were carried out the blends of B10 and B20 oils for biodiesel source.

MATERIALS AND METHODS

Collection

The *Pongamia pinnata* seeds were collected from Kani settlement of Mothiramali, of Agasthiamalai Biosphre Reserve Forest of Kanyakumari District in Tamilnadu, India.

Pongamia pinetta

Extraction

The seeds were dried, dehulled and the impurities were removed by hand picking. The seed were crushed by mechanical method, using an oil expeller. The oil was filtered and stored for further analysis.

Blend preparation

The diesel used for the experiment was purchased at Bharat Petroleum, Marthandam Tamilnadu, India. The blends were made on a volume basis and stored in glass bottles at room temperature. A blend of 20% neat oil with 80% conventional petroleum diesel, by volume, is termed "B20" and a blend of 10% neat oil with 90% conventional petroleum diesel, by volume, is termed "B10". The Physico Chemical studies were carried out for the blends of biodiesel and compared with the ASTM and EN standards.

Physico- Chemical Analysis

Pongamia pinnata oil blends (B10 and B20) were analyzed for various physical chemical properties. The physical parameters studied were pH, specific gravity, viscosity, density, and significant biodiesel properties like fire point, flash point, smoke point, cloud point, carbon residue. The general physical parameters include conductivity, salinity, total dissolved solid, and total dissolved oxygen. The acidimetric constant chemical properties such as the Acid value, Iodine value and Saponification value were analyzed. The pH was determined by using Elico pH meter. The specific gravity and density was measured by using Borosil glass bottle method. Viscosity was measured by using calibrated Ostwald Viscometer. 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 Seta Smoke point apparatus. Carbon residue was determined by using Conradson carbon residue apparatus. 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.

RESULTS

The oil content of the dried seed of *Pongamia pinnata* is about 40% on dry weight basis. The General physical properties of the biodiesel blends (10% and 20%) such as pH, Specific gravity, Density, Viscosity, fire point, flash point, Cloud point, Pour point, Smoke point, Carbon residue were measured. The results were given in the Table-1. The chemical properties such as Acid value. Iodine value and Saponification value were recorded for the biodiesel blends and given in the Table -2.The Ultrasonic parameters namely ultrasonic velocity, ultrasonic compressibility, relaxation time, acoustic impedance were studied for diesel and the blends of *Pongamia pinnata* oil with conventional diesel with B10 and B20 proportions are furnished in the Table3.

Table 1: General Physical properties of *Pongamia pinnata* oil blends B10, B20 and diesel

Parameters	*Pongamia pinnata* Oil Blends		Diesel
	B10	B20	
pH	3.98	4.74	6.8
Specific Gravity	0.8355	0.8489	0.880
Density (g/ml)	1.2215	1.2411	0.804g/cm^3
Viscosity(Nm-2s)	3.850	4.500	3.5
Fire point	53.7	57.6	54.0^{o}C
Flash point	46.9	55.8	47.2^{o}C
Cloud point	4	6	3^{o}C
Pour point	2	3	0^{o}C
Smoke point	5	6	9mm
Carbon residue	0.2	0.3	0.2g

DISCUSSION

The pHs of biodiesel blends is lower than the petro diesel which also indicates the biodiesel is more acidic than the conventional diesel due to the presence of fatty acid. The specific gravity is important when considering the spray characteristic of the fuel within the engine. 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 fire point of the blends B20 is slightly higher and B10 is lesser than that of petro diesel, and which falls within the range of ASTM standard. The flash point of these B10 is higher and B20 is slightly higher than that of petro diesel and the values are within the range specified for petro diesel. So it clearly indicated that biodiesel is safer to handle than fossil fuel.

Table 2: Chemical Properties of *Pongamia pinnata* oil blends B10, B20 and diesel

Parameters	*Pongamia pinetta* Oil Blends		Diesel
	B10	B20	
Acid value (mg KOH/g)	0.44	0.58	16.31
Iodine value	89.95	93.45	6.84
Saponification value	192.43	198.75	180.41

Table 3: Ultrasonic Properties of *Pongamia pinnata* oil blendsB10, B20 and diesel

Parameters	*Pongamia pinetta*		Diesel
	B10	B20	
Ultrasonicvelocity10^6m/s	1.32	1.364	1.356
UltrasonicCompressibility$\times10^{-12}$kg^{-1}ms^{-2}	0.684	0.638	0.639
Relaxation Time $\times10^{-12}$s	3.441	3.180	3.493
Acousticimpedance$\times10^6$kgm^{-2}s^{-1}	1.122	1.158	1.153

The cloud point is slightly higher than the petro diesel, and the pour point is slightly higher than the petro diesel. The Smoke points of the biodiesel blend are lesser than the petro diesel but within the ASTM standard value. The carbon residue is slightly higher than the petro diesel. The medium 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 lower 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 higher 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 value of B10 is higher and B20 is higher than that of the petro diesel. However the Saponification value is found to be within the acceptable-range of biodiesel.

The ultrasonic study is a novel method for screening the biodiesel. It is a cheap, quick and best method for the screening of vegetable oil for its potentiality for biodiesel. The ultrasonic velocities and Acousticimpedance of the biodiesels were very close to that of diesel. The ultrasonic compressibility and the relaxation time of the biodiesel blends have a slight less than the diesel. These variations are because of the slight changes in their density with that of the petro-diesel.

CONCLUSION

Pongamia can be cultivated from Kanyakumari to the foot hills of Himalayas, because of the adaptability of the plant. It occurs in wild as well as cultivated along the roadsides and railway tracks as an avenue tree. There is a possibility of collecting the seeds in large scale from the natural vegetation. It thrives well in the various types of soil and climatic conditions. Physical properties of the oil blends are almost equal to or very near to ASTM and EN standards. The plant can be used as an avenue tree, ornamental, medicinal and also possess timber values. It can be also used as a biomass source for energy purposes. The nectar produced from the trees are used for the apiculture purposes. It flowers mostly in the summer season and it adds beauty to the environment. The main propagation is from seeds. The oil cake is used as an animal feed. It can be used as a bio manure and pesticide also because of the high protein content. Because of the above reasons this plant could be exploited as alternative source for renewable energy. The oil content is above

40% and the yield potential is also high. The oil as well as the gas emition from the oil is nontoxic. As the plant belongs to the family Fabaceae, it increases the soil fertility by producing of root nodules in the root system. It has great impact on the environmental nitrogen fixation and enhances the nitrogen content in the lithosphere.

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