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Research Article

PHYSICO CHEMICAL STUDIES ON SOAP NUT (*SAPINDUS TRIFOLIATUS*) OIL FOR SOURCE AS BIODIESEL

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ABSTRACT

Objective: *Sapindus trifoliatus* is a small tree belongs to the family Sapindaceae. Soap nut powder is a very good antibacterial and antifungal agent. It is mostly used in the cosmetic and contraceptive creams. It has a number of health benefits besides the famous benefit of keeping the hair long and healthy. It is useful in the treatment of lice's and dandruff. It is also used as a detergent, bio-surfactant and remedial for organic soil pollution in the modern science. In this present study, the physico-chemical properties of the soap nut oil was analyzed by blending with conventional diesel at 10% (B10) and 20% (B20) proportions. **Methodology:** The properties assessed in the physical parameters include pH, density salinity, viscosity, specific gravity, conductivity, total dissolved oxygen, and total dissolved solid. The significant biodiesel characters such as flash point, fire point, smoke point, pour point, and cloud point and carbon residue were analyzed. **Results:** The ultrasonic characters such as ultrasonic velocity, adiabatic compressibility, acoustic impedance, relaxation time were also assessed. **Conclusion:** The chemical parameters estimated such as acid value, iodine value and saponification value. The values of the parameters were compared with the ASTMT standards of biodiesel. The biodiesel blend B20 is found to be within the ASTM standard, and it can serve as a potential source for biodiesel.

Keywords: Soap nut, *Sapindus trifoliatus*, Conductivity, Ultrasonic velocity, Saponification.

INTRODUCTION

Soap nut is a small deciduous tree belongs to the family Sapindaceae. It is one of the most important trees of tropical and sub-tropical regions of Asia. It is commonly found in the Western Ghats and plains of South India [1]. It is a native species grown in Indo-Gangetic plains, Shiva hills and Sub-Himalayan tracts in India at altitudes ranges from 200 m to 1500 m [2]. *Sapindus trifoliatus* which is known as soap nut in English, Ritha in Bengali and Ponnangottai in Tamil [3]. This tree flourishes well in deep clay loamy soil with an annual rainfall of 200 mm. It is a medium sized tree can reaches a height of 25 m. The flowers are small greenish white in color, and the fruits are solitary globose appears in the month of July-August. The fruit contains an active principle saponin which ranges from 6% to 10% of mass weight [4]. All parts of the *S. trifoliatus* contain phenolic acids such as protocatechuic acid, cis -p- coumaric acid, p-hydro benzoic acid and cinnamic acid [5]. The plant is very commonly used in Indian Ayurvedic healing system. It is also used in Unani and Tibetan indigenous medicine. For Asthma and cough, it is given as an expectorant. It is an effective ingredient in Ayurvedic shampoos and cleansers. Soap nuts are used for eczema and psoriasis. It is having antibacterial, antifungal, insecticidal properties [6]. The powdered seeds are used for the treatment of arthritis, common cold, constipation, nausea, and dental caries [6]. The poultice of soap nut is prepared, and it is applied on the affected portions of joints for the relief from joint pains [7]. Soap nut cold water extract is hyper allergenic and very effective in neurodermatitis and inhibit platelet aggregation [8]. The alcoholic extract of soap nut is reported to possess anti-implantation activity [9]. It also possess anti-cancerous property against breast cancer cell lines [10,11]. Biodiesel is an alternative fuel to petroleum-based diesel fuel, and it is defined as mono-alkyl ester of a long chain fatty acid derived from renewable lipid sources such as vegetable oils or animal fats. It can be blended at any level with diesel to create biodiesel. It can be used in combustion ignition (diesel) engines which require no engine modification [12]. Ultrasonic studies on several vegetable oils have been reported [13]. The ultrasonic velocity and attenuation depends on the frequency of operation of the interferometer. Ultrasonic studies are an excellent non-destructive technique for probing the nature of the material. The property of liquid can be investigated through the propagation of ultrasonic waves. Ultrasonic studies provide a wealth of information about liquids [14]. The measurement of ultrasonic velocity in pure sample is an important technique to study the physicochemical property and explains the nature of the interaction [15]. Using ultrasonic parameters we can screen the vegetable oils (edible or non- edible) for a potential biodiesel source [16,17]. In this present study, the physicochemical properties of the soap nut oil blends B10 (10%) and B20 (20%) were evaluated for its use as an alternative source of energy.

METHODS

The soap nut seeds were collected from Forest of Agasthyamalai Biosphere, Tamil Nadu, The fruits were dried, dehulled and the impurities were removed by handpicking and the seeds 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. The diesel used for the experiment was purchased at Bharath Petroleum, Nagercoil, Tamil Nadu, India. 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 physicochemical evaluation studies were carried out for the blends of biodiesel.

Soap nut oil blends (B10 and B20) were analyzed for its various physical-chemical properties. The general physical parameters studied were pH, specific gravity, viscosity, density, conductivity, total dissolve oxygen, total dissolved solid, salinity, and significant biodiesel properties such as fire point, flash point, smoke point, cloud point, carbon residue. The ultrasonic characters such as ultrasonic velocity, adiabatic compressibility, acoustic impedance, and relaxation time. 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 Brosil 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 Smoke point apparatus. Carbon residue was determined by using Conradson carbon residue apparatus. The ultrasonic studies were carried out by using Ultrasonic interferometer (Mittal and Co.) with a frequency of 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.

RESULTS

The oil content of the dried seed of soap nut is about 30% on dry weight basis. The significant Physical properties of soap nut oil such as pH, specific gravity, viscosity, density, and total dissolved solid, total dissolved oxygen were measured for blends at 10%, 20% proportions. The results were given in Table 1. The general physical properties of the oil such as pH, specific gravity, density, viscosity, 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 properties of the soap nut were measured for blends of 10% and 20%. The results were given in the Table 3. The chemical properties of the oil like acid value. Iodine value and saponification value results were recorded and given in the Table 4.

The pH of biodiesel blends are slightly less than the petro diesel which 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 a 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 B10 and B20 are almost equal, and the B20 are slightly higher than that of petrodiesel, 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 petrodiesel. 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 petrodiesel. However, the Saponification value is found to be within the acceptable range of biodiesel.

Table 1: General physical properties of soap nut oil blends B10, B20 and diesel

Parameters	Soap nut oil blends		Diesel
	B10	B20	
pH	8.89	7.48	6.8
Specific gravity	0.8286	0.8291	0.880
Density (g/ml)	1.2018	1.2117	0.804 g/cm^3
Viscosity (Nm-2s)	4.7010	5.0212	3.5
Conductivity (µs)	0.60	0.59	0.00
Salinity (ppt)	9.3	9.4	0.00
Total dissolved solid (ppm)	0.27	0.27	0.00
Total dissolved oxygen (ppm)	0.00	0.00	0.00

Table 2: Significant physical properties of soap nut oil blends B10, B20 and diesel

Parameters	Soap nut oil blends		Diesel
	B10	B20	
Fire point	38.6	40.7	54.0°C
Flashpoint	33.9	34.5	47.2°C
Cloud point	4°C	6°C	3°C
Pour point	2°C	2°C	0°C
Smoke point	8 mm	11 mm	9 mm
Carbon residue	0.12	0.16	0.2 g

Table 3: Ultrasonic properties of soap nut oil blends B10, B20 and diesel

Parameters	Soap nut oil blends		Diesel
	B10	B20	
Ultrasonic velocity(×10^6 m/s)	1.7168	1.7569	2.180
Adiabatic compressibility (kg^{-2}s^{-1})	0.4095	0.3908	0.35
Acoustic impedence (×10^6 kg^{-2}s^{-1})	1.4225	1.4566	1.55
Relaxation time (secs)	2.5665	2.4492	3.93

Table 4: Chemical properties of soap nut oil blends B10, B20 and diesel

Parameters	Soap nut 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

Ultrasonic velocity for the oil blends B10 and B20 of soap nut are slightly lower than the petro diesel. Adiabatic compressibility explains about the interaction of molecules between the oil and diesel. In blends of soap nut biodiesel, B10, B20 proportions are slightly lower than that of diesel. The relaxation time of the soap nut oil blends B10 and B20 are slightly lower than that of diesel.

CONCLUSION

The present study concluded that the kernel contains 30% of a fatty acid, approximately 85% of triglycerides and sterol. The oil extracted from the kernel is used as a bio-fuel [8]. It can be directly blend with the fossil fuel at the maximum of 20%. Soap nut seed has a great potential source for an inhibitory agent for the bio-corrosion of mild steel and copper alloys. Fruit can be used for cleaning the teeth, polishing jewelry. The physicochemical property reveals that that the oil blend B20 could be a potential source for biodiesel.

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