A comparative evaluation of physical and chemical characteristics of biofuel synthesized from kusum oil (Schleichera oleosa) and its blends with diesel

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Abstract - *Biodiesel derived from nonedible feed stocks such as Kusum seed (Schleichera oleosa) is reported to be feasible choices for developing countries including India. Kusum biodiesel is prepared from kusum seed through trans-esterification. This paper presents comparative results of investigation of physical and chemical properties of biofuel synthesized from kusum oil and its blends with diesel. In this investigation, the blends of varying proportions of Kusum biodiesel and diesel were prepared, analyzed the characteristics compared with diesel. Various physico-chemical parameters of the kusum oil have been studied to evaluate its suitability as a potential feedstock for biodiesel production. However, deviation from the properties became larger for higher blending ratio. Therefore, in order to get engine performance in close range of diesel, the optimum blending ratio are lower blending ratio such as B10, B20. Lower blends are expected to give engine characteristics in close proximity to diesel overcoming the limitations of biofuels, while retaining the advantages.*

Key Words: Biodiesel, Kusum seed & oil (Schleichera oleosa), Transesterification, Kusum Biodiesel, Biodiesel blends B10, B20.

1. INTRODUCTION

Biodiesel can be produced from a wide variety of plant oils, both edible and non-edible biodiesel. In recent years systematic efforts have been made by several researchers to use vegetable oils like sunflower, cottonseed, peanut, soybean, rapeseed, palm, olive, linseed, coconut, pongamia and rubberseed etc. as alternate fuel for diesel. Many of the vegetable oils are edible in nature, continuous use of them cause shortage for food supply and proves far expensive to be used as fuel at present. So far a very few of non-edible vegetable oils have been tried on diesel engine leaving a lot of scope in this area. Therefore, it is desirable to produce biodiesel from the non-edible oils which can be extensively grown in the waste lands of the country. Among the non-edible oil sources, Jatropha, Karanja, Mahua, Neems, Sal and Kusum are identified as potential biodiesel source and comparing with other sources, which have added advantages as rapid growth, higher seed productivity, suitable for tropical and subtropical regions of the world like India.

1.1 Biodiesel

Biodiesel is a mono-alkyl ester produced through trans-esterification processes. It is obtained from the transesterification of vegetable oil. Transesterification reaction is the transformation of an ester, in this case, a triglyceride (vegetable oil) and alcohol, ethanol, into another ester in the presence of acid or base as a catalyst. In the production of biodiesel, the products are mixtures of fatty esters (biodiesel) and glycerol.

Fig-1 Kusum Fruit on Tree

1.2 Characteristics Kusum seed (Schleichera oleosa)

In India, Kusum is one of the forest-based tree-borne nonedible oil. The botanical name of kusum is widely found in the sub-Himalayan region, throughout central (Chhattisgarh) and southern India. The estimated availability of kusum seed is about 25,000 tons per annum. In the past kusum seed oil was exported from India to Germany. This market has now fallen away. From current production potential 4000 to 5000 tons are collected. The one or two almost round seeds some 1.5cm in diameter and weighing between 0.5 and 1.0g. The oil content is 51-62% but the yields are 25-27% in village ghanis and about 36%oil in expellers. The viscosity of kusum oil was found to be higher than that of diesel fuel. The high viscosity of kusum oil may be due to its larger molecular weight compared to diesel. The flash point of kusum oil was higher than diesel and hence it is safer to store.

Fig-2 Kusum Seed

1.3 Extraction of Kusum oil from its seed

The extraction of Kusum oil was done by using a screw extruder machine in oil mill. Additional process by hydraulic manual pressing machine was performed to increase the oil yield from Kusum seed which repeated for several times. The Kusum seeds were afterward sun dried for one week then cleaned. Seed samples were cooked in an oven for 2 h then were pressed with four replications in the screw press oil expeller at an optimum screw-speed of 120 rpm. At each of test conditions, crude oil and cake were collected and weighed. The remained cake was wrapped with a filter and placed inside the press machine. The extraction with press machine was done several times and after the pre-determined time, the extraction process stopped. The oil yield of Kusum seed was calculated by the following equation:

$$\text{Oil yield} = (O_{SO}/W_{SO}) \times 100$$

Where, O_{SO} = the extracted weight of Kusum seed (S. oleosa oil) (g), W_{SO} = the weight of Kusum seed (S. oleosa oil) (g).

1.4 Characterization of Kusum oil

The chemical and physical properties of the jatropha and Neem oil as well as the biodiesel obtained from them were determined with the view of characterizing the oil and the biodiesel. The major properties determined includes the density, specific gravity, iodine value, acid value, free fatty value, moisture content. Ash content, saponification value, flash point, cloud point, freezing point and pour point.

Table-1 Properties of Kusum oil and KOME

Property	Unit	Kusum oil	Kusum oil Methyl Ester
Density at 40°C	kg/m3	860	850
Viscosity at 40°C	cSt	40.36	14.2
Flash point	°C	225	150
Fire point	°C	231	157
Calorific value	MJ/kg	38.14	41.65

2. PRODUCTION OF BIODIESEL FROM KUSUM OIL (TRANSESTERIFICATION)

A great variety of new approaches, based on different principles such as supercritical fluid extraction, microwave irradiation, closed system at high temperature and pressure have been developed in the last few years. Another problem with non-edible vegetable oil seeds is that they contain high free fatty acids and are not suitable as a feed stock for production of biodiesel by conventional alkaline transesterification method. Therefore, to use high free fatty acid and high moisture contain oil as a feed stock for production of biodiesel, several techniques have been proposed in recent years like acid catalyzed lipase catalysed and super critical transesterification. The transesterification reaction proceeds with catalyst or without catalyst by using primary or secondary monohydric aliphatic alcohols.

$$RCOOR^1 + R^2OH \leftrightarrow RCOOR^2 + R^1OH$$

Table - 2 Properties of Kusum Biodiesel & its blends

Properties	Diesel	Kusum oil	B10	B20	B30	B40
Specific Gravity	0.831	0.876	0.834	0.842	0.848	0.851
Viscosity at 400c (cSt)	4.3	4.5	5.3	6.1	7	7.3
Flash point (oC)	54	172	78	90	98	105
Fire point (oC)	65	198	93	121	135	144
Calorific Value(kj/kg)	42500	37710	42250	41638	41015	40500

3. CONCLUSION

This complete understanding of production of biodiesel from Kusum seeds will help in commercializing the product and will also help our economy by reducing the import of crude oil. The result of biodiesel characterization shows that the fuel fulfills most of the ASTM and EN Standard so can be used as a possible candidate for replacement for petroleum diesel.

ACKNOWLEDGEMENT

Grateful thanks to HOD and faculty of department of Mechanical Engineering, Government Engineering College, Jagdalpur, Chhattisgarh for allowing the use of their institutional facilities.

REFERENCES

[1] Sahoo PK, Das LM, Babu MKG, Naik SN. "Biodiesel development from high acid value polanga seed oil and

performance evaluation in a CI engine". Fuel 86(2007) 448–54.

[2] Gandhi M, Ramu N, Bakkiya Raj S. "Methyl ester production from Schlichera oleosa". International Journal of Pharmaceutical Science Research 2(2011) 1244–50.

[3] Bhatia H, Kaur J, Nandi S, Gurnani V, Chowdhury A, Reddy PH, et al. "A review on Schleichera oleosa". Pharmacological and Environmental aspects. J Pharm Res 6(2013) 224–9.

[4] Ferella F, Mazziotti Di Celso G, De Michelis I, Stanisci V, Vegliò F. "Optimization of the transesterification reaction in biodiesel production" 89(2010) 36–42.

[5] Atadashi IM, Aroua MK, Abdul Aziz AR, Sulaiman NMN. "Production of biodiesel using high free fatty acid feedstocks". Renewable Sustainable Energy Rev 16(2012) 3275–85.

[6] Koh MY, Ghazi TIM. "A review of biodiesel production from Jatropha curcas oil". Renewable Sustainable Energy Rev 15(2011) 2240–51.

[7] Mofijur M, Masjuki HH, Kalam MA, Atabani AE. "Evaluation of biodiesel blending, engine performance and emissions characteristics of Jatropha curcas methyl ester". Malaysian perspective Energy 55(2013) 879–87.

[8] Dhar A, Kevin R, Agarwal AK. "Production of biodiesel from high-FFA neem oil and its performance, emission and combustion characterization in a single cylinder CI engine". Fuel Process Technology 97(2012) 118–29.

[9] Abbaszaadeh A, Ghobadian B, Omidhkhah RM, Najafi G. "Current biodiesel production technologies: a comparative review". Energy Conversion Management 63(2012) 138–48.

[10] L.C. Meher, D. VidyaSagar, S.N. Naik. "Technical aspects of biodiesel production by transesterification—a review", Renew. Sustain. Energy Rev. 10(2006) 248–268.

[11] S.P. Singh, D. Singh. "Biodiesel production through the use of different sources and characterization of oils and their esters as the substitute of diesel: a review", Renewable Sustainable Energy Rev. 14(2010) 200–216.

[12] S.V. Ghadge, H. Raheman. "Process optimization for biodiesel production from mahua (Madhuca indica) oil using response surface methodology". Bioresour. Technology 97(2006) 379–384.

[13] A.K. Tiwari, A. Kumar, H. Raheman. "Biodiesel production from jatropha oil (Jatropha curcas) with high free fatty acids: an optimized process". Biomass Bioenergy 31(2007) 569–575.

[14] Shahid EM, Jamal J. "Production of biodiesel: a technical review". Renewable Sustainable Energy Rev 15(2011) 4732–45.

[15] Lin L, Zhou C, Saritporn V, Shen X, Dong M. "Opportunities and challenges for biodiesel fuel". Appl Energy 88(2011) 1020–31.

[16] Ashraful AM, Masjuki HH, Kalam MA, Rizwanul Fattah IM, Imtenan S, Shahir SA, Mobarak HM. "Production and comparison of fuel properties, engine performance, and emission characteristics of biodiesel from various nonedible vegetable oils: a review". Energy Convers Manage 80(2014) 202–28.

[17] Atabani AE, Silitonga AS, Ong HC, Mahlia TMI, Masjuki HH, Badruddin IA, Fayaz H. "Non-edible vegetable oils: a critical evaluation of oil extraction, fatty acid compositions, biodiesel production, characteristics, engine performance and emissions production". Renewable Sustainable Energy Rev 18(2013) 211–45.

[18] Kumar A, Sharma S. "Potential non-edible oil resources as biodiesel feedstock: an Indian perspective". Renewable Sustainable Energy Rev 15(2011) 1791-00.

[19] Murugesan A, Umarani C, Subramanian R, Nedunchezhian N. "Bio-diesel as an alternative fuel for diesel engine: A review". Renewable and Sustainable Energy Reviews 13(2009) 653-62.

BIOGRAPHIES

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