ANNALS OF FACULTY ENGINEERING HUNEDOARA
- INTERNATIONAL JOURNAL OF ENGINEERING
Tome IX (Year 2011). Fascicule 3. (ISSN 1584 - 2673)

1. Natesan KAPILAN, 2. Chandra B. SEKAR

# PRODUCTION AND EVALUATION OF STORAGE STABILITY OF HONGE BIODIESEL

1-2. NAGARJUNA COLLEGE OF ENGINEERING AND TECHNOLOGY, DEVANAHALLI, BANGALORE, INDIA

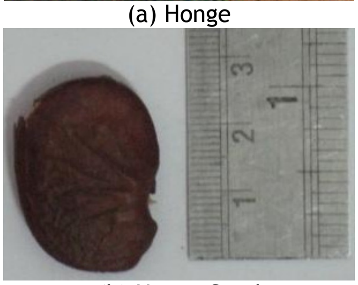
ABSTRACT: Biodiesel is considered as a renewable substitute for diesel oil in the compression ignition engine. But the biodiesel is more prone to oxidation due to its chemical nature. The products of the oxidation cause the biodiesel to become acidic and to form insoluble gums and sediments that can plug fuel filters. In India, biodiesel is derived from non-edible oils sources, in particular honge and jatropha oils. In the present work, biodiesel was derived from honge oil by a two-step transesterification. The honge oil contains more amounts of unsaturated fatty acids and hence storage stability study was carried-out for 6 months, to study its storage stability. From the storage stability study of the honge biodiesel, we observe that the acid value, iodine value and saponafication value of the honge oil biodiesel varies with the storage period. The honge oil biodiesel should not be stored above 6 weeks, to avoid deterioration in its fuel properties.
KEYWORDS: Alternative fuel, biodiesel, honge oil, properties, storage stability

## INTRODUCTION

India is one of the developing countries which imports crude oil from other countries to meet the local demands of petroleum products. In government of India's biofuels policy, biodiesel derived from non-edible oils is considered as a substitute for diesel. Among the available non-edible oils, honge oil has considerable potential for the production of biodiesel.

The botanical name of the honge is pongamia pinnata and is a medium sized tree. It generally attains a height of about 8 m and a trunk diameter of more than 0.50 m. The alternate, compound pinnate leaves consist of 5 or 7 leaflets which are arranged in 2 or 3 pairs and a single terminal leaflet. The flowers are pink or light purple in colour. Its pods are elliptical and each pod contains usually a single seed which has 30 to 35% oil content. The seeds are 10 to 20 cm long and light brown in color. The number of honge plants which can be planted in an acre is 200. The yield per tree is 25 to 40 kg depends on the age, region, soil, climate etc. Figure 1 (a) and (b) shows the honge tree and seed [1].


(a) Honge


(b) Honge Seed
Figure 1.

Malaya et al [2] produced biodiesel from honge oil containing high free fatty acids (FFA) using a two-step method. Avinash et al [3] used mixture of honge oil and diesel as a fuel in diesel engine. From the experimental work, they concluded that the honge oil blends with diesel up to 50% (v/v) without preheating as well as with preheating would replace diesel for running the diesel engine for lower emissions and improved performance. Baiju et al [4] studied the effects of blends of honge biodiesel and diesel on the performance and emission characteristics of a single cylinder diesel engine. They concluded from their study that a little power loss, combined with an increase in fuel consumption, is often encountered due to the lower calorific value of the honge biodiesel and CO, HC and smoke emissions are reduced with the use of neat biodiesel and the blends.

Gerhard [5] reported that the major technical issue facing biodiesel is its susceptibility to oxidation upon exposure to oxygen in ambient air. This susceptibility is due to its content of unsaturated fatty acid chains. He reported that the oxidation of fatty acid chains is a complex process that proceeds by a variety of mechanisms. Abderrahim et al [6] results show that the acid value, peroxide value and viscosity, increased while the iodine value decreased with increasing storage time of the brassica carinata biodiesel. They also found that the fatty acid ethyl esters from brassica carinata oil were very stable. Francielle et al [7] evaluated the susceptibility to bio-deterioration of biodiesel, diesel, and diesel containing 5, 10, and 20% biodiesel using fungi isolated from contaminated oil systems. They reported that the yeasts had the highest rates of degradation, especially candida silvicola, with 100% degradation of all esters.

Dantas et al [8] investigated the oxidative stability of corn biodiesel, obtained by base-catalyzed transesterification reaction. They characterized the biodiesel stability by measuring peroxide value, iodine value and dynamic viscosity. Abdul et al [9] evaluated the impact of oxidized biodiesel on engine performance and emissions. They reported that, compared with unoxidized biodiesel, oxidized biodiesel produced 15 and 16% lower exhaust CO and HC emissions respectively and observed no significant difference in smoke and NOx emissions of the oxidized and unoxidized biodiesel. María et al [10] studied the influence of the raw material composition on biodiesel quality. Fuel properties can be strongly affected if the biodiesel has been improperly stored or transported. The biodiesel quality is harmed by the oxidation products, which are corrosive to engine chambers and may lead to clogging of the injection pumps and filters, besides increasing the biodiesel viscosity.

From the literature review, it is observed that the biodiesel is prone to oxidation and hence storage of biodiesel over a long period of time is an important concern to be addressed. Hence in this work, storage stability of the honge biodiesel was studied.

## ❖ MATERIALS AND METHODS

In the present work, honge oil, methanol, $H_2SO_4$ and KOH were used as vegetable oil, alcohol, acid catalyst and base catalyst respectively. A two-step transesterification reaction was used for the production of biodiesel. Biodiesel was produced using a 25 litre biodiesel plant. The honge biodiesel was stored in the plastic container and every week, biodiesel samples were taken out for the determination of acid value, iodine value and viscosity.

## ❖ RESULTS AND DISCUSSION

The biodiesel was produced from honge oil using a two-step transesterfication in a small scale biodiesel plant. The biodiesel yield obtained in this method is 92.5%. The fatty acid composition of the biodiesel was determined using Gas Chromatography (GC). From the analysis of GC spectra, the fatty acid composition was determined. Table 1 shows the fatty acid composition of the honge oil biodiesel. From the table, it is observed that the honge biodiesel contains more amounts of oleic acid and linoleic acid. These unsaturated fatty acids increase the oxidation of the honge biodiesel during storage period.

Table 1. Fatty Acid Composition

| Fatty Acids | Percentage |
|---|---|
| Palmitic Acid | 9.77 % |
| Stearic Acid | 7.33 % |
| Oleic Acid | 35.72 % |
| Linoleic Acid | 19.17 % |
| Linolenic Acid | 4.17 % |
| Arachidonic Acid | 1.29 % |
| Behenic Acid | 5.84 % |

Table 2. Properties of Biodiesel and Diesel

| Property | ASTM D6751 | Honge Biodiesel | Diesel |
|---|---|---|---|
| Flash point (°C) | >130 | 142 | 68 |
| Pour point (°C) | -- | 8 | -15 |
| Calorific Value ( MJ/kg) | -- | 36.84 | 42.71 |
| Viscosity at 40° C ($mm^2$/sec) | 1.9-6 | 4.7 | 2.28 |
| Density at 15°C (kg/$m^3$) | -- | 890 | 846 |
| water content (mg / kg) | <500 | | 102 |
| Acid number (mg KOH/ g) | <0.50 | 0.45 | 0.34 |
| Copper strip corrosion | >No.3 | 1 | 1 |
| Ash Content (%) | <0.02 | 0.01 | 0.01 |

The properties of the honge oil biodiesel are shown in Table 2. From the table it is observed that the properties of the honge biodiesel satisfy the biodiesel fuel standards.

The effect of storage period on viscosity of the honge biodiesel is shown in Figure 2. From the figure, it is observed that the viscosity of the biodiesel increases during the storage period. This is due to the oxidation of the biodiesel which causes the formation of soluble polymers. These polymers will tend to cause viscosity to increase during the storage period.

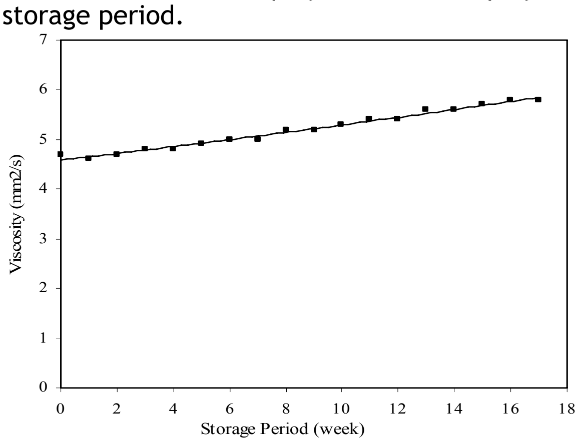


Figure 2. Effect of Storage Period on Viscosity

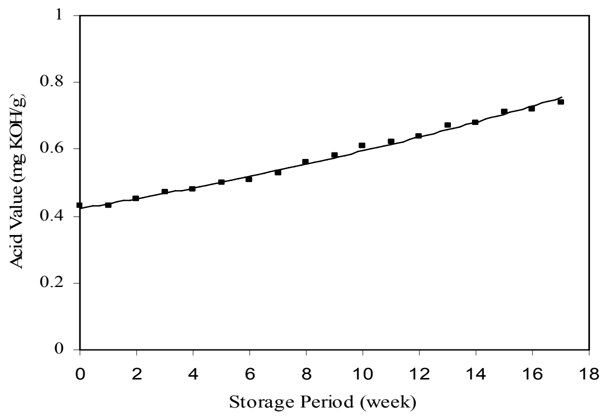


Figure 3. Effect of Storage Period on Acid Value

Figure 3 shows the effect of storage period on the acid value of the biodiesel. From the figure, it is observed that the acid value of the biodiesel increase with the increase in storage period. This is because of formation and decomposition of peroxides which results in the formation of aldehydes and higher acidity. According to the ASTM standards, the acid value should not exceed 0.5 mg KOH per g of oil. Hence to keep the acid value within the limit, honge biodiesel should not be stored more than 4 weeks.

Figure 4 shows the effect of storage period on iodine value. The iodine value is a structure related index in chemistry that relates to the total number of double bonds in a fat or oil. From the figure, it is observed that the iodine value of the biodiesel decreased during storage period. It indicate that the oxidation of the biodiesel which results in reduction in double bonds.

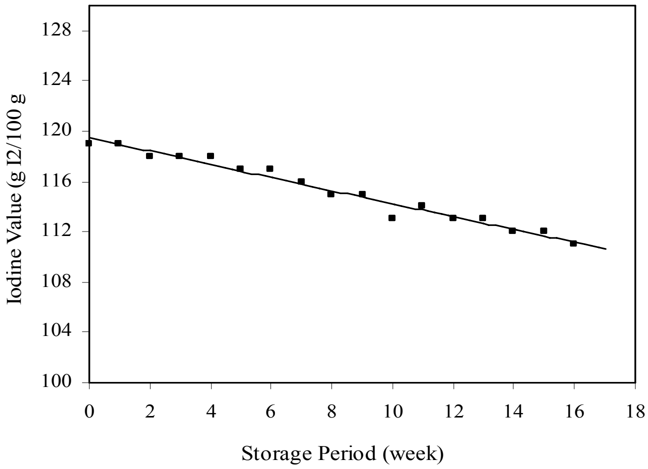



Figure 4. Effect of Storage Period on Iodine Value

## ❖ CONCLUSIONS

From this work, the following conclusions are drawn. Biodiesel can be produced from honge oil by two-step transesterification using a biodiesel plant. The properties of the honge biodiesel satisfy the biodiesel fuel standards. The honge oil contains more than 50% unsaturated fatty acids which makes them prone to oxidation. During the storage period of six month, the acid value and viscosity of the honge biodiesel were increased but the iodine value decreased. From the study it is observed that the safe storage period of the honge biodiesel is 4 weeks.

## ❖ ACKNOWLEDGMENT

The authors wish to express their thanks to Visvesvaraya Technological University, Belgaum, for financially supporting this research work (Grant No. VTU/Aca./2009-10/A-9/11583, 2009). Authors also thank Bangalore Test House, India, for GC analysis of biodiesel samples.

## ❖ REFERENCES

[1.] http://www.svlele.com/karanj.htm
[2.] Malaya Naika, L.C. Meherb, S.N. Naikb, L.M. Das, Production of biodiesel from high free fatty acid Karanja (Pongamia pinnata) oil, Biomass and Bioenergy, 32 ( 2008 ) 354 – 357.
[3.] Avinash Kumar Agarwal, K. Rajamanoharan, Experimental investigations of performance and emissions of Karanja oil and its blends in a single cylinder agricultural diesel engine, Applied Energy 86 (2009) 106–112.
[4.] B. Baiju, M.K. Naik, L.M. Das, A comparative evaluation of compression ignition engine characteristics using methyl and ethyl esters of Karanja oil, Renewable Energy 34 (2009) 1616–1621
[5.] Gerhard Knothe Some aspects of biodiesel oxidative stability, Fuel Processing Technology, 88(7), 2007, 669-677.
[6.] Abderrahim Bouaid, Mercedes Martinez, Jose Aracil, Production of biodiesel from bioethanol and Brassica carinata oil: Oxidation stability study, Bioresource Technology, 100 (7), 2009, 2234-2239.
[7.] Francielle Bücker, Naiara Aguiar Santestevan, Luiz Fernando Roesch, Rodrigo J. Seminotti Jacques, Maria do Carmo Ruaro Peralba, Flávio Anastácio de Oliveira Camargo, Fátima Menezes Bento, Impact of biodiesel on biodeterioration of stored Brazilian diesel oil, International Biodeterioration & Biodegradation, 65(1), 2011, 172-178.
[8.] M.B. Dantas, A.R. Albuquerque, A.K. Barros, M.G. Rodrigues Filho, N.R. Antoniosi Filho, F.S.M. Sinfrônio, R. Rosenhaim, L.E.B. Soledade, I.M.G. Santos, A.G. Souza, Evaluation of the oxidative stability of corn biodiesel, Fuel, 90(2), 2011, 773-778.
[9.] Abdul Monyem, Jon H. Van Gerpen, The effect of biodiesel oxidation on engine performance and emissions, Biomass and Bioenergy, 20(4), 2001, 317-325.
[10.] María Jesús Ramos, Carmen María Fernández, Abraham Casas, Lourdes Rodríguez, Ángel Pérez, Influence of fatty acid composition of raw materials on biodiesel properties, Bioresource Technology, 100(1), 2009, 261-268

ANNALS OF FACULTY ENGINEERING HUNEDOARA
– INTERNATIONAL JOURNAL OF ENGINEERING

Faculty of Engineering Hunedoara,
5, Revolutiei, 331128, Hunedoara,
ROMANIA
http://annals.fih.upt.ro