

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Special Issue 6, May 2015

## Performance Analysis of Two Biodiesel Blended with Various Diesel Ratio

R.Thirunavukarasu, B.Suresh kumar,

Student, M.E-Thermal Engineering, Sri Ramakrishna Engineering College, Coimbatore, India

Professor, M.E-Thermal Engineering, Sri Ramakrishna Engineering College, Coimbatore, India

**ABSTRACT:** The world faces the energy demand, increased petroleum rates and decrease of fossil fuel resources. Biodiesel has extracted from vegetable oils that have been considered as an alternate fuel. The researches regarding blend of diesel and single biodiesel have been carried out already. A few works have been attempted with the combination of two different biodiesel blends with diesel and left with a lot of scope in this thrust area.

The present study takes out an experiment of two biodiesels from PONGAMIA PINNATA oil and NEEM OIL. They are blended with diesel at various mixing ratios. The effects of two biodiesel works in engine were checked in a single cylinder, direct injection for pongamiapinnata oil and Neem oil, air cooled and high speed diesel engine at various engine loads with constant engine speed of 2500 rpm. The influences of blends on CO, CO<sub>2</sub>, HC, NO<sub>x</sub> and smoke opacity were investigated by emission tests. The brake thermal efficiency of blend was found higher than diesel.

The emissions of smoke, hydro carbon and nitrogen oxides of two biodiesel blends were higher than that of diesel. But the exhaust gas temperature for dual biodiesel blends was lower than diesel.

**KEYWORDS:**(Blend two diesel, pongamia pinnata and neem oil, alternative fuel)

### 1. INTRODUCTION

Bio fuel is a type of fuel whose energy is derived from biological carbon fixation. It is obtained directly from naturally. Decrease of fossil fuel resources and environmental degradation so now we have Interest in the search for alternative fuels for internal Combustion engine. As one of most believable in renewable energy, biodiesel has been widely studied in present years for CI engines. Biodiesel is biodegradable, non-toxic and can be substituted for diesel fuel with little or no engine modification. Biodiesel is had very good some properties better than diesel fuel in terms Of very less sulfur content and it is also having high flash and fire point temperatures than in diesel fuel. The application of biodiesel as a supplement fuel in compression ignition engine can decrease reliance on petroleum product, reduce hazardous pollution and strengthen agricultural economy. In this research study, the effect of a two biodiesels from pongamiapinnata oil and neem oil Biodiesel on performance of engine was investigated in a DI diesel engine.

#### Nomenclature

PD –petroleum diesel  
PPBD -pongamiapinnatabio diesel  
PPO - pongamiapinnata oil  
NBD - neem bio diesel  
NO - neem oil  
SFC - specific fuel consumption  
BSEC - brake specific energy consumption  
TFC - total fuel consumption  
HC - hydro carbon  
NO<sub>x</sub>- nitrogen oxides  
CO - carbon monoxide  
CO<sub>2</sub> - carbon dioxide  
PO -pongamia pinnata oil

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## II. MATERIALS AND METHODS

The two biodiesels are prepared by the transesterification process.  
The dual biodieselBlends were prepared in different proportions as:

### Blend A

PD 90%, PPBD 5% and NBD 5% by volume basis;

### Blend B

PD 80%, PPBD 10% and NBD 10% by volume basis;

### Blend C

PD 60%, PPBD 20% and NBD 20% by volume basis;

### Blend D

PD 40%, PPBD 30% and NBD 30% by volume basis;

### Blend E

PD 20%, PPBD40% and NBD 40% by volume basis and

### Blend F

PD 0%, PPBD 50% and NBD 50% by volume basis

The various fuel properties specific gravity, viscosity, calorific value, flash point and fire point temperatures of raw oils and dual biodiesel blends were determined by using method of ASTM and compared with petroleum diesel properties. The experiments were conducted on a four stroke single cylinder air cooled diesel engine with electrical dynamo meter loading and the performance characteristics were compared with data of petroleum diesel fuel. Tests were conducted at a constant speed and at differentloads for all dual biodiesel blends. Engine speed was maintained at 2500 rpm (rated speed) during all experiments. Three experiments for each load were carried out for accuracy. Fuel consumption and exhaust gas temperatures were also measured.

The smoke opacity of the exhaust gases was measured by the AVL make smoke meter. The exhaust emissions weremeasured by the five gas Analyser. The experimental set up is shown in Fig. 1 and the detailed engine specifications are also given in Table 1.

Table 1. (Engine specification)

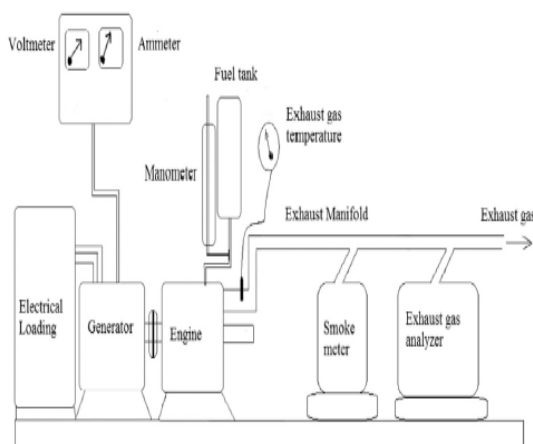


Fig. 1(Test Engine setup)

Sr. no.	Items	Specifications
1	Model	KIRLOSKAR, AV1
2	Compression ratio	19:1
4	Type, no. of cylinders	4 stroke, 1 cylinder
5	Bore x stroke(mm)	87.5x110
6	Cubic capacity	624
7	Maximum power	5 Hp
8	Nominal speed	2500 rpm
9	Cooling system	Air cooled

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## III. RESULTS AND DISCUSSION

Different physical and thermal properties of dual biodiesels of pongamia pinnata and neem oil its blends were evaluated. The performance of the engine was evaluated using several parameters such as thermal efficiency, specific fuel consumption and exhaust gas temperature

### 3.1. Calorific value of fuels

The digital bomb calorimeter is used to find out the calorific value of fuels. ASTM D420 procedure is followed to analyse the calorific value of different test fuels. fig 2 shows the calorific value of different fuels. The raw vegetable oil has lower calorific value than diesel. After transesterification process, the biodiesels have slightly higher calorific value than raw oil. The pongamia pinnata ethyl ester has higher calorific value than neem oil ethyl ester. By blending the dual biodiesels

With diesel, the calorific values of Blend A and Blend B are close to diesel. The calorific values of Blend C, Blend D, Blend E and Blend F all are got calorific values lower than the blends A and B.

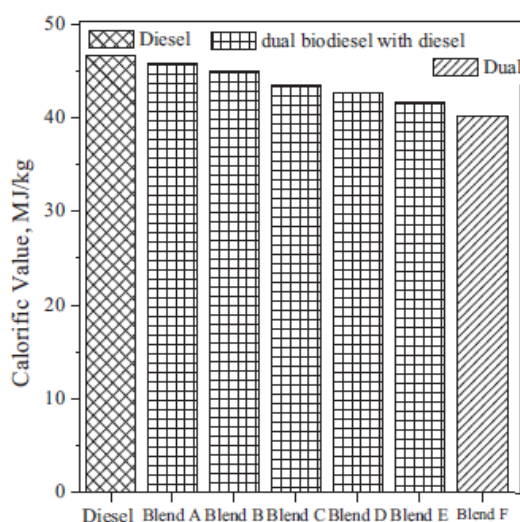


Figure 2(Calorific value for various blends)

### 3.2. Specific gravity of fuels

Specific gravity of different dual blends is measured using a Precision hydrometer. the specific gravity value shown in table 2

Specific gravity of diesel 0.814.

Table 2. (Specific gravity of fuels)

Blends with diesel	pongamia pinnata biodiesel +neem biodiesel
A	0.816
B	0.828
C	0.839

The other blends Specific gravity values have more deviation than diesel Specific gravity value.

### 3.3. Viscosity of fuels mm<sup>2</sup>/sec

Redwood viscometer is used for determining the kinematic viscosity.

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The viscosity of the raw pongamia pinnata oil and neem oil is very high compared to diesel. However, the high viscosities of raw oils are reduced by the transesterification process. Viscosity of dual biodiesel blends Blend A Blend B and blend C is nearer to diesel. Viscosity of blends value show in table 3  
The viscosity of diesel is 4

Table 3.( Viscosity of fuels mm<sup>2</sup>/sec)

Blends with diesel	Pongamia pinnata biodiesel +neem biodiesel
A	4.2
B	4.4
C	4.5

## IV. PERFORMANCE ANALYSIS

### 4.1 Variation of brake power on specific fuel consumption

The effect of brake power on specific fuel consumption is shown in Fig. 3. As brake power increases the SFC reduces for all the dual biodiesel blends. For the maximum load, the value of SFC of Blend A is 0.31kg/kW h, Blend B is 0.34 kg/kW h, Blend C is 0.36 kg/kW h whereas diesel fuels have 0.30 kg/kW h. The higher SFC for the dual biodiesel fuel consumption is due to the lower calorific value of the blends.

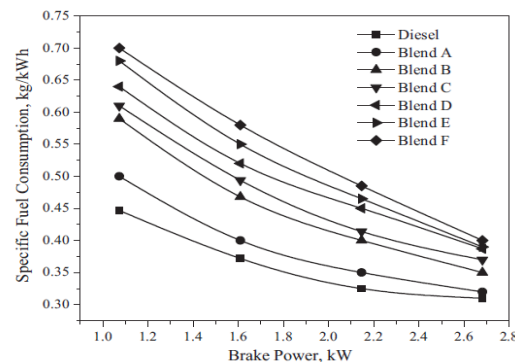


Figure 3 Variation of brake power on specific fuel consumption

### 4.2 Effect of brake power on brake specific energy consumption

Brake specific energy consumption (BSEC) was used for comparing engine performance of fuels with different calorific values. Fig. 4 signifies the brake specific energy consumption for dual biodiesel, its blends and diesel. It shows that the BSEC is the highest for all dual biodiesel blends compared with mineral diesel. BSEC is an ideal variable because it is dependent on calorific value of the fuel. The high specific energy consumption is due to the lower energy content of the ester

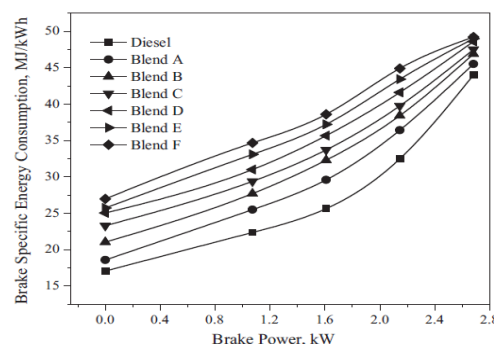


Figure 4 Effect of brake power on brake specific energy consumption

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## 4.3 Effect of brake power on mechanical efficiency

Hence the brake specific energy consumption of the dual biodieselblends increases as compared to that of diesel. The effect of brake power on mechanical efficiency is shown in Fig. 5. Indicated power and engine friction are essential for calculating the mechanical efficiency of the engine. Efficiency is measured as a ratio of the measured performance to the performance of an ideal machine. Mechanical efficiency measures the effectiveness of a machine in transforming the energy and power that is given as an input to the device into an output force and movement. Hence, mechanical efficiency indicates how good an engine is, in converting the indicated power to useful power. Blend A gives the maximum mechanical efficiency of 79.3% for the maximum brake power, whereas the diesel gives 78.2% at the same brake power. For the other blends, mechanical efficiency is lower than diesel.

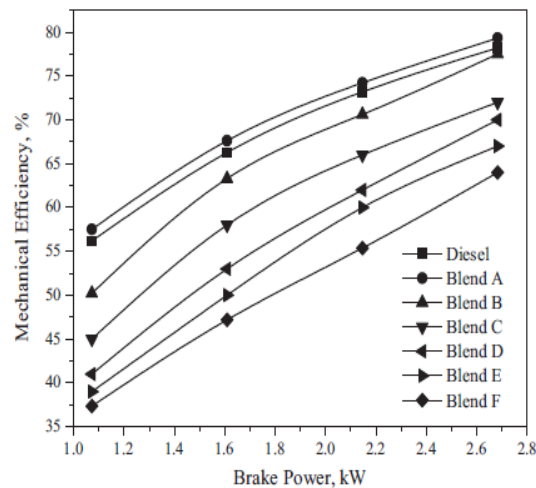


Figure 5 Effect of brake power on mechanical efficiency

## 4.4 Variation of brake power on exhaust gas temperature

The variations of brake power on exhaust gas temperatures are shown in Fig. 6. Exhaust temperature increases with the increase in brake power in all cases. Exhaust gas temperature is an indicative of the quality of combustion in the combustion chamber. The increase in exhaust gas temperature with engine load is clear from the simple fact that, more amount of fuel is required by the engine to produce the extra power which is also needed to take up the additional loading. At the same time, all the blends are having less exhaust temperature than the diesel values for any brake power due to its lower heating value and the improved oxygen content provided by the dual bio diesel which increases better combustion.

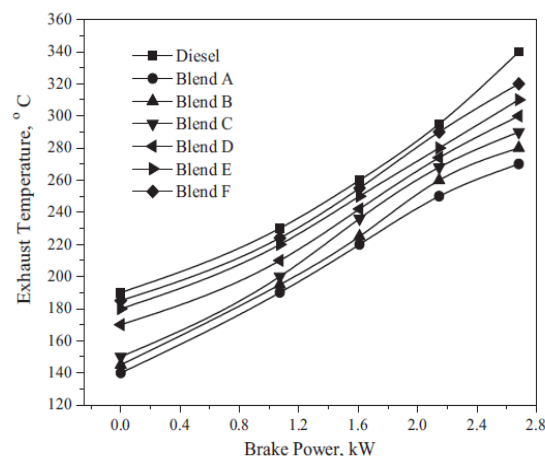


Figure 6 Variation of brake power on exhaust gas temperature.

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## 4.5 Effect of brake power on exhaust smoke.

Hence, the dual biodiesel blends are better than diesel while considering the exhaust temperature effect. It is observed from Fig. 7, that the smoke percentage increases with the increase in the brake power. For the maximum load, the smoke for diesel was 60%, whereas the Blend A gives 64% and Blend B gives 68% with the same maximum load. Blend A has a closer smoke value with diesel. In other blends, the smoke percentage was more than the diesel with the same brake power. The higher density and viscosity may be the reason for more smoke emissions as compared to neat diesel. The high viscosity of pure biodiesel deteriorates the fuel atomization and increases exhaust smoke.

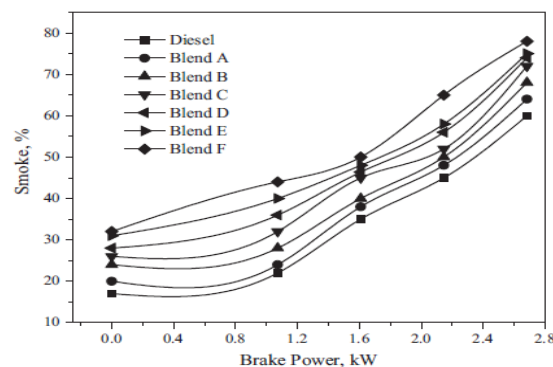


Figure 7 Effect of brake power on exhaust smoke.

## 4.6 Variation of brake power on carbon monoxide emission.

The variations of brake power on Carbon monoxide are shown in Fig. 8. Carbon monoxide's (CO) content is also increasing with BP

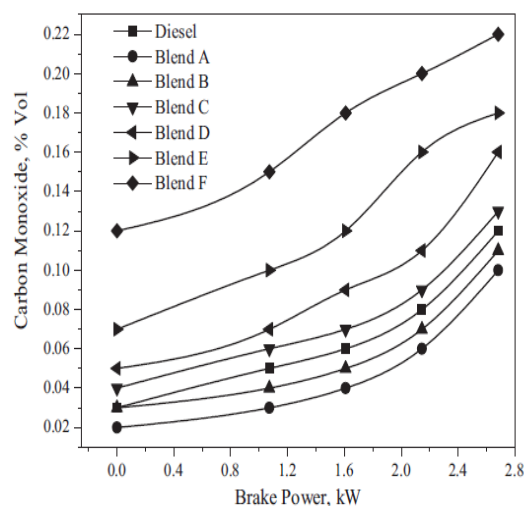


Figure 8 Variation of brake power on carbon monoxide emission.

## 4.7 Variation of brake power on carbon dioxide emission

Blend A and Blend B give lower CO than diesel. The same trend is shown in Fig. 9 for carbon dioxide (CO<sub>2</sub>) emission. Blend A and Blend B give lower CO and CO<sub>2</sub> than diesel at maximum load. This is due to the oxygen contents in the biodiesel which makes easy burning at high temperature in the cylinder. The other blends are deviated from diesel. This is due to the high viscosity; the air-fuel mixing process is affected by the difficulty in

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atomization and vaporization of dual biodiesels. In engine load is higher, richer fuel-air mixture is burned and thus more CO and CO<sub>2</sub> are produced.

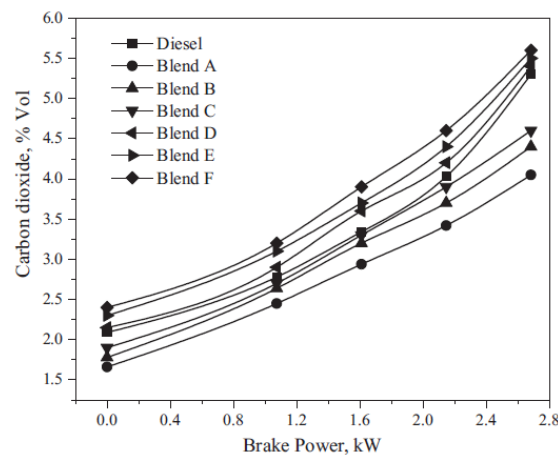


Figure 9 Variation of brake power on carbon dioxide emission

## 4.8 Effect of brake power on nitrogen oxide emission.

The effect of brake power on nitrogen oxides is shown in Fig. 10. The nitrogen oxides (NO<sub>x</sub>) increased by increasing the load for each blend. For the maximum load, Blend A gives 166 ppm whereas diesel gives 150 ppm, Blend B gives 180 ppm, Blend C gives 190 ppm at the same maximum load. From the results, NO<sub>x</sub> emission is higher for dual biodiesel blends than diesel. However, Blend A gives lesser NO<sub>x</sub> than other dual biodiesel blends. The vegetable oil based biodiesel contains a small amount of nitrogen. This contributes toward NO<sub>x</sub> production. All the blends give higher NO<sub>x</sub> than diesel. The higher average gas temperature, the presence of fuel oxygen and residence time at higher load conditions with the blend combustion caused higher NO<sub>x</sub> emissions.

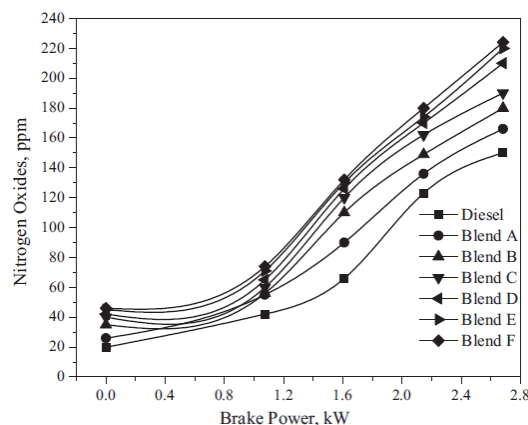


Figure 10 Effect of brake power on nitrogen oxide emission.

## 4.9 Effect of brake power on hydro carbon emission.

Fig. 11 shows that, the relation between brake power and hydro carbon (HC) increased by increasing the load for each blend. All the Blends give higher HC than diesel. From the results, Blend A gives lesser HC than other blends. The dual biodiesels and blends generally exhibit lower HC emission at lower engine loads and higher HC emission at higher engine loads. This is because of the relatively less oxygen available for the reaction when more fuel is injected into the engine cylinder at high engine load. The lower calorific value and the higher viscosity of biodiesel oil result in the highest HC emissions.



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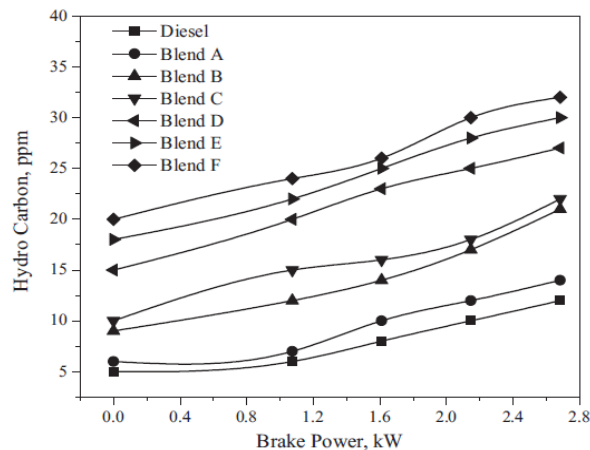


Figure 11 Effect of brake power on hydro carbon emission.

## V. CONCLUSION

This study shows that performance of two bio diesels pongamia pinnata and neem blended with various diesel ratios. Where reducing the dependence on fossil fuels. the thermal efficiency and mechanical efficiency of Blend A were slightly higher than the diesel. Blend B and Blend C were very closer to the diesel values. biodiesel blends of Blend A, Blend B and Blend C would be used as an alternative fuel for diesel in the diesel engines.

## REFERENCES

1. Agarwal, D., Kumar, L., Agarwal, A.K., 2008. Performance evaluation of a vegetable oil fuelled compression ignition engine. *Renew. Energy* 33, 1147–1156.
2. Deepanraj, B., Dhanesh, C., Senthil, R., et al, 2011. Use of palm oil biodiesel blends as a fuel for compression ignition engine. *Am. J. Appl. Sci.* 8, 1154–1158.
3. Forson, F.K., Oduro, E.K., Hammond-Donkoh, E., 2004. Performance of jatropha oil blends in a diesel engine. *Renew. Energy* 29, 1135–1145.
4. Ghaly, A.E., Dave, D., Brooks, M., et al, 2010. Production of biodiesel by enzymatic transesterification: review. *Am. J. Biochem.*
5. Qi DH, Chen H, Geng LM, Bian YZ. Effect of diethyl ether and ethanol additives on the combustion and emission characteristics of biodiesel-diesel blended fuel engine. *Renewable Energy*. 2011;**36**:1252-8.
6. Mat Yasin MH, Yusaf T, Mamat R, Fitri Yusop A. Characterization of a diesel engine operating with a small proportion of methanol as a fuel additive in biodiesel blend. *Applied Energy*. 2014;**114**:865-73
7. Lapuerta M, Armas O, Herreros JM. Emissions from a diesel–bioethanol blend in an automotive diesel engine. *Fuel*. 2008;**87**:25-31.
8. Chen H, Shi-Jin S, Jian-Xin W. Study on combustion characteristics and PM emission of diesel engines using ester–ethanol–diesel blended fuels. *Proceedings of the Combustion Institute*. 2007;**31**:2981-9.
9. Sayin C. Engine performance and exhaust gas emissions of methanol and ethanol–diesel blends. *Fuel*. 2010;**89**:3410-5.
10. Guido C, Beatrice C, Napolitano P. Application of bioethanol/RME/diesel blend in a Euro5 automotive diesel engine: Potentiality of closed loop combustion control technology. *Applied Energy*. 2013;**102**:13-23.
11. Zhu L, Cheung CS, Zhang WG, Huang Z. Combustion, performance and emission characteristics of a DI diesel engine fueled with ethanol–biodiesel blends. *Fuel*. 2011;**90**:1743-50
12. G.L.N. Rao, S. Saravanan, S. Sampath and K. Rajgopal. 2006. Emission characteristics of a direct injection diesel engine fuelled with bio-diesel and its blends. *Proceedings of the International Conf. on Resource Utilization and Intelligent Systems, India*. Allied publishers private limited. pp. 353-356.
13. M.A. Kalam and H.H. Masjuki. 2002. Biodiesel from palm oil-an analysis of its properties and potential. *Biomass and Bioenergy*. 23: 471-479.
14. S. Puhani, N. Vedaraman, G. Sankaranarayanan and B.V.B. Ram. 2005. Performance and emission study of mahua oil (madhuca indica oil) ethyl ester in a 4 stroke natural aspirated direct injection diesel engine. *Renewable Energy*. 30: 1269-1278.
15. M.M. Azam, A. Waris and N.M. Nahar. 2005. Prospects and potential of fatty acid methyl esters of some non-traditional seed oils for use as biodiesel in India. *Biomass and Bioenergy*. 29: 293-302.
16. H. Raheman and A.G. Phadatar. 2004. Diesel engine emissions and performance from blends of karanja methyl ester and diesel. *Biomass and Bioenergy*. 27: 393-397.
17. S. W. Lee, T. Herage and B. Young. 2004. Emission reduction potential from the combustion of soy methyl ester fuel blended with petroleum distillate fuel. *Fuel*. 83: 1607-1613.