

# **Experimental Investigation of Performance and Emission Characteristics of Diesel Engine using Jamun Seed Oil (*Syzygium Cumini*) Blends with Diethyl Ether as Additive**

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**ABSTRACT:** The objective of this project is to investigate the mechanical properties and performance characteristics of bio diesel extracted from jamun seed oil. The objective is achieved by trans esterification of the jamun seed oil with methanol and potassium hydroxide. Experimental investigation have been carried out to monitor fuel properties and performance and emission characteristics of dissimilar biodiesel blends in comparison to diesel. The performance characteristics of blends can be evaluate at variable loads at stable rated speed of 1500rpm and results are compare with diesel. Brake Thermal efficiency, Specific fuel consumption and Emissions like CO, HC, NO<sub>x</sub>, CO<sub>2</sub> are studied in comparasion with conventional diesel.

**KEYWORDS:** Jamun seed oil, Methanol, KOH as catalyst, Trans esterification, Diethyl ether.

## **I. INTRODUCTION**

Today world facing crisis of fossil fuel deflection and environmental degradation due to ever increasing of vehicles. Fossil fuels are limited resources and hence search for renewable fuels is becoming more and more important issue of energy security and environmental protection.

Alternate fuels from biomass and bio diesel is one of the opportunities that could overcome the future energy demand. Bio diesel is prepared from animal fat, vegetables, seeds and leafs of different plants which is having oil content. Biodiesel is a renewable source of energy that can help reduce green house gas emissions and minimize the “carbon footprint” of agriculture. It contributes less to global warming because the carbon in the fuel was removed from the air by the plant feed stock. These type of oils cannot be directly used in diesel engines due to high viscosity. The performance of oils improved by transesterification process with the help of alcohols. Transesterification process separates the glycerin from the oil or fat. The resulting product, Biodiesel is thinner than the original oil or fat and thus works better in a diesel engine.

Biodiesel is simple to use, biodegradable, nontoxic, and essentially free of sulphur and aromatics. It is usually used as a petroleum diesel additive to reduce levels of particulates, carbon monoxide, hydrocarbons and toxics from diesel-powered vehicles. When used as an additive, the resulting diesel fuel may be called B5, B10 or B20, representing the percentage of the biodiesel that is blended with petroleum diesel.

The authors Senthil Ramalingam<sup>1</sup> observed that BTE of JAME20 is closer to diesel. Peak pressure and pressure rate are poor with JAME than diesel earlier start of combustion and shorter ignition delay. Visnusrathy Dhakshinamurthy<sup>2</sup> concluded that it shows B30 blend yields 3.5% more brake thermal efficiency. Specific fuel consumption decreases by 8.8%. Reduction in CO, CO<sub>2</sub>, HC, Smoke density particularly NO<sub>x</sub> emission of B30 decreases by 3.2% when compared to diesel. J. Tharun, G. Prabhakara Ramesh<sup>3</sup> suggested from their work is the anti-oxidant properties of the jamun seed which is assumed to reduce the levels of oxide formation was proved to be ineffective. And

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there by giving unyielding results. There has been a enormous increase in the oxide formation levels however the unexpected reduced emissions of HC Hexane has captured the importance of jamun seed. Abdurrahman Sayduta, M. Zahir Duzb<sup>4</sup> has declared that Evaluate Transesterified sesame (Sesamum indicum L.) seed oil as a biodiesel fuel. Sesame seed oil have about 7.5% less heating value than that of diesel oil due to the oxygen content in their molecules. Viscosity and density of methyl esters of sesame seed oil are found to be very close to that of diesel. The calorific value of biodiesel is found to be slightly lower than that of diesel (5.4%). P.K. Devan, N.V. Mahalakshmi<sup>5</sup> conclude by their work is the results show a 49% reduction in smoke, 34.5% reduction in HC emissions and a 37% reduction in CO emissions for the Me50–Eu50 blend with a 2.7% increase in NOx emission. There was a 2.4% increase in brake thermal efficiency for the Me50–Eu50 blend at full load. M.Gumus, S.Kasifoglu<sup>6</sup> Conducted Performance and emission evaluation of a compression ignition engine using a biodiesel (apricot seed kernel oil methyl ester) and its blends with diesel fuel. It shows higher percent of ASKOME blend (B50) and neat ASKOME reduced CO, HC emission and smoke density in exhaust effectively. N.L. Panwar, Hemantshrirame<sup>7</sup> exhibits from their work is the blend B10 exhibits a calorific value about 45.50 MJ kg<sup>-1</sup> that is only 2% lower than that of diesel. NOx emission for CME are same as that of diesel at lower loads and slightly higher at full loads.

Amar Pandharand Atul Padalkar<sup>8</sup> Investigates on Performance and Emission Characteristics of Diesel Engine with Biodiesel (Jatropha Oil) and its Blends. The brake thermal efficiency was found to increase with increase in compression ratio. The CO and The HC emissions decreased by 7 to 10% with CR 19.5 as compared with CR 17.5 at all biodiesel blend ratios. S. Siva Lakshmi, T. Balusamy<sup>9</sup> concludes that the addition of diethyl ether into biodiesel, the brake thermal efficiency and brake specific fuel consumption is improved with the use of BD5. The CO and smoke emissions are lower for BD5. M.Jindal, P.Rosha<sup>10</sup> explained that experimental Investigation Of performance & emission characteristics of waste cooking oil as biodiesel nBu10 when compared to B0 increased the BSFC by 38.3% and the HC content by 19.9%. CO emissions were reduced by 22.53%, while NOx emissions increased by 3.6%.

## II. EXPERIMENTAL SETUP AND METHODOLOGY

### 1. Experimental Setup



(a)

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S.NO	Particulars	Description
1	Engine type	Four stroke, single cylinder, vertical water cooled diesel engine
2	Bore diameter	87.50 mm
3	Stroke length	110.00 mm
4	Compression ratio	17.5:1
5	Rated power	5.20 Kw
6	Speed	1500 rpm
7	Dynamometer	Eddy current type

**Table-1: Engine Specifications**

## 2. Experimental Methodology and Properties

The process of converting oils into biodiesel is called Trans esterification. In this process, we take jamun seed oil to make it as useful biodiesel. Initially 200 ml methanol and 5g of KOH were mixed in correct proportions of the measured quantity and mixed thoroughly pellets of KOH dissolved in methanol. Oil is taken and heated up to a temperature of 60-65°C water particles will be evaporate. After heated oil is cooled to 60°C. Methanol and KOH were mixed with jamun seed oil continuously stirring at constant temperature of 60°C with 600 rpm speed. In this way continuously heating this mixture up to 1-2 hrs. After heating 2 hours the oil is poured in conical flask and placed for 12-16 hours for settling methyl ester and glycerine were separated. Then removed the free fatty acids and glycerin from the flask. Separated oil is carried out for water wash. Initially take the 500 ml of water into the 1000 ml of jamun seed oil then those to be mixed thoroughly and well shake. The solution mixture was settled for 24 hours after that the water and glycerin removed. In order to remove the any amount of methanol left in the oil are removed by water washing. After settlement separate the oil and glycerin. After that the oil heated up to 100°C because of if there any water particles present in oil is evaporated.

Initially the engine was started with neat diesel fuel and warmed at low idle, long enough to establish the recommended oil pressure. The warm up period ended when the liquid cooling water temperature was stabilized and was checked for any fuel and lube oil leaks. Then the fuel consumption and exhaust emissions of CO, HC, NOx and smoke were measured and recorded for different loads. Similar procedures were repeated for the jamun bio fuel. The experiments were carried out by using neat diesel as the base line fuel i.e. it was denoted by (B10) 10% biodiesel+90% diesel, 30% biodiesel+70% diesel (B30), at different engine loads from 0 to 100% rated engine load in approximate steps of 25%. Before running the engine to a new fuel, it was allowed to run for sufficient time to consume the remaining fuel from the previous experiment or remove the oil from that engine. To measuring the performance parameters, important operating parameters such as power output, fuel consumption, exhaust emissions and cylinder pressure wave measured. Engine performance parameters such as Specific fuel consumption and brake thermal efficiency for biodiesel and its blends were measured.

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**Table.2 Properties of Jamun seed Oil and its Blends**

Properties	Diesel	JB100	JB10	JB30	JB10+5%DEE
<b>Kinematic viscosity @40°C in CSt</b>	3.2	6.30	3.28	3.58	2.93
<b>Flash point</b>	58 <sup>0</sup> C	155 <sup>0</sup> c	68°C	86.5°C	63 <sup>0</sup> C
<b>Fire point</b>	62 <sup>0</sup> C	165 <sup>0</sup> c	72.3°C	92.9°C	70.1 <sup>0</sup> C
<b>Gross calorific value kj/kg</b>	43400	36543	43,249.5	41,791.7	38,390.12
<b>Density @15°C in kg/m<sup>3</sup></b>	840	915	865	873	840

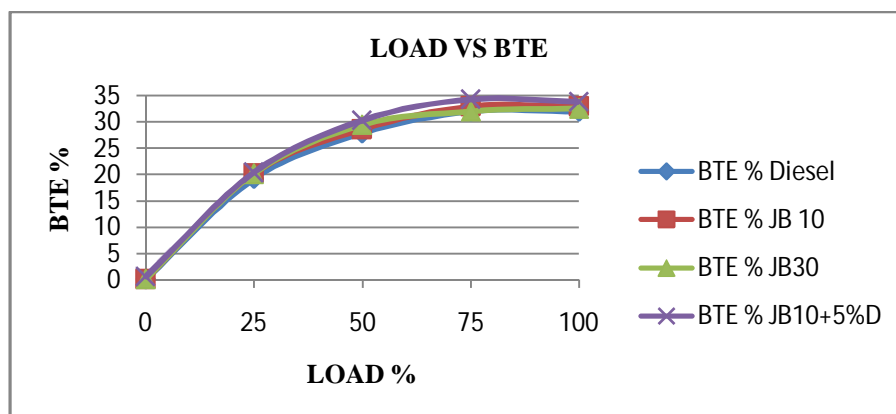
### III. EXPERIMENTAL RESULTS AND DISCUSSIONS

We discuss the results of performance characteristics and emission characteristics obtained for Jamun seed blends like JB10, JB30 & JB10+5% DEE (Di ethyl ether) and compare with diesel in this section.

#### Performance Characteristics

##### 1. Brake Thermal Efficiency:

Graph shows that the variation in brake thermal efficiency in case of diesel JB10,JB30 and JB10+5% DEE. Among different Bio diesels blends, JB10 showed better BTE than conventional diesel fuel. By adding Di Ethyl Ether to JB10 the efficiency is increases compare to all blends. Because of less viscosity and it causes improvement in fuel spray characteristics and atomization. These finer fuel droplets tend to mix thoroughly with air and hence improving the combustion.



(b)

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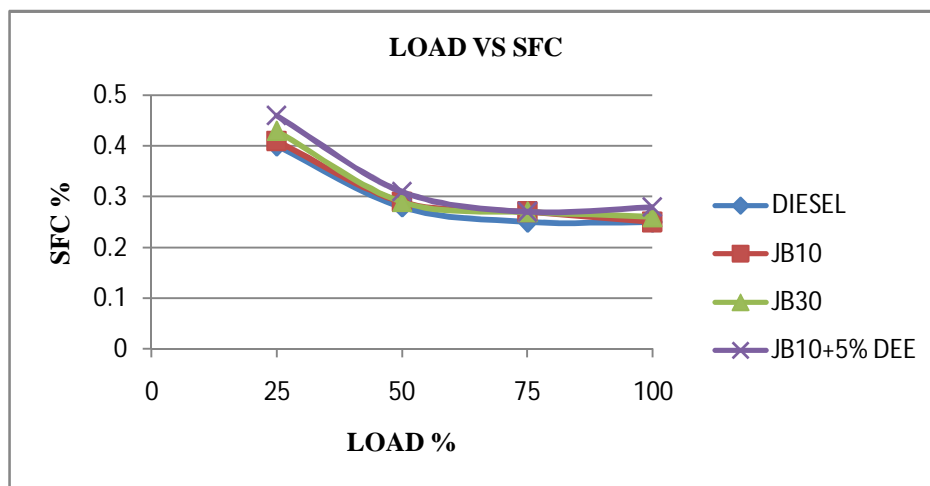
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### 2. Specific Fuel Consumption (SFC) :

From the graph observed that JB10 and JB30 SFC has equal to diesel. By adding Di Ethyl Ether to JB10 SFC slightly increases compare to other blends because of low calorific. If calorific value increases obviously SFC decreases. This is due to the fact that esters of vegetable oils have lower heat value.

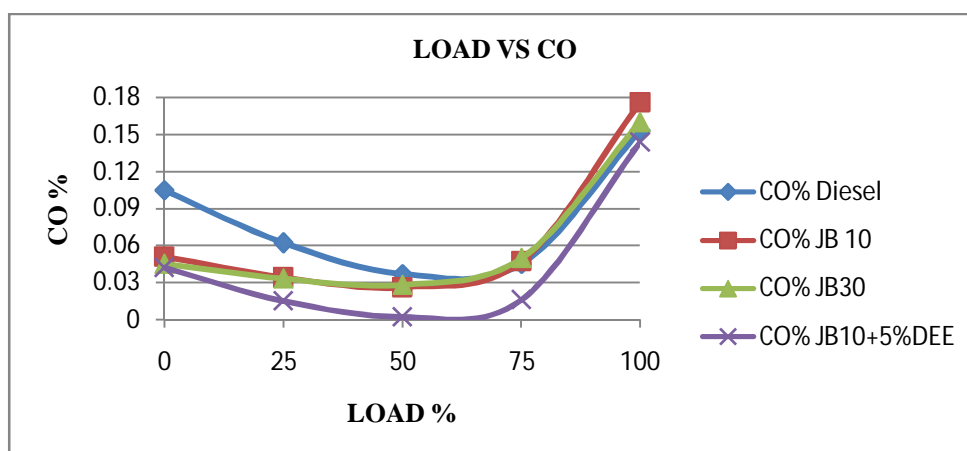


(c)

### Emission Characteristics

#### 1. CO Emissions:

From the graph observed that the variations of CO emission of various biodiesel blends and diesel with respect to different loads. It is observed that the emissions of CO initially decrease at lower loads and then increase sharply for all the prepared test fuels. To avoid this we have to use an additive 5% of Di Ethyl Ether to JB10. CO decreases for all the prepared blends at higher load condition. Because of good spray characterization, good air fuel ratio and proper combustion.



(d)

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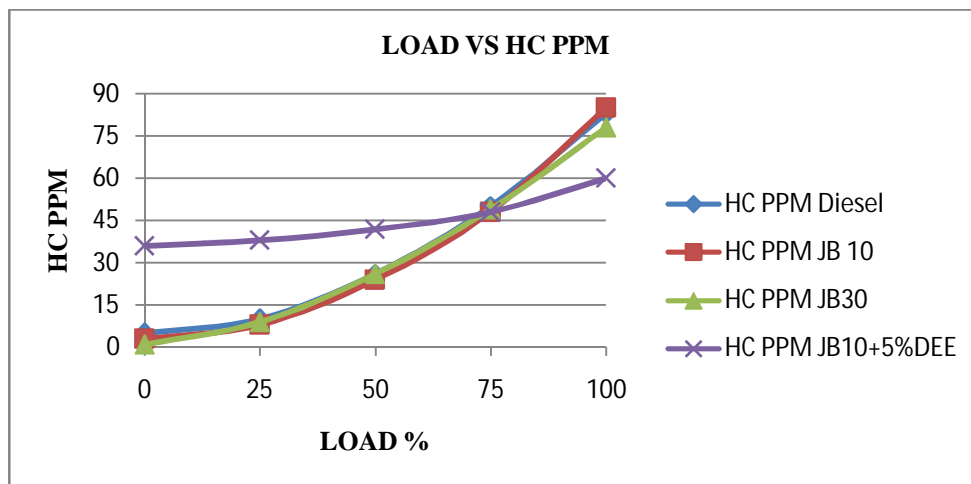
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### 2. HC Emissions :

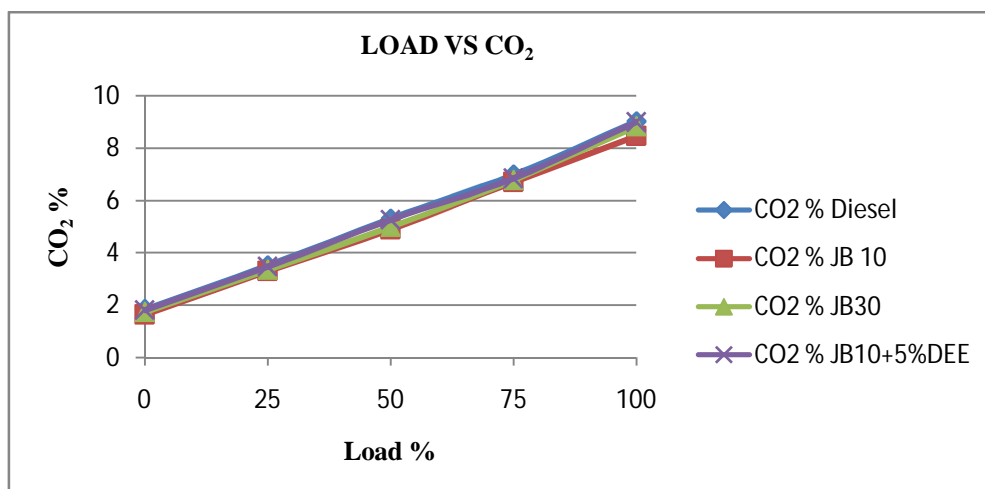
From the graph observed that HC emissions of JB10 shows the highest HC emissions compared to other test fuels. This is due to incomplete combustion of biodiesel fuel. To avoid this, we have to use an additive 5% of Di Ethyl Ether to JB10 HC decreases for all the prepared blends at higher load condition. Because of good spray characterization, good air fuel ratio and proper combustion. The main reason for reduction in HC emissions is supported air fuel mixing and excess oxygen in the additive mixtures.



(e)

### 3. CO<sub>2</sub> Emissions :

From the graph observed that that CO<sub>2</sub> emission increases with increase in blends ratio of Jamun biodiesel. JB10 shows less CO<sub>2</sub> emission compare to remaining test fuels except at full load condition. Increasing the load percentage then CO<sub>2</sub> emissions are increases rapidly for fuel blends.



(f)



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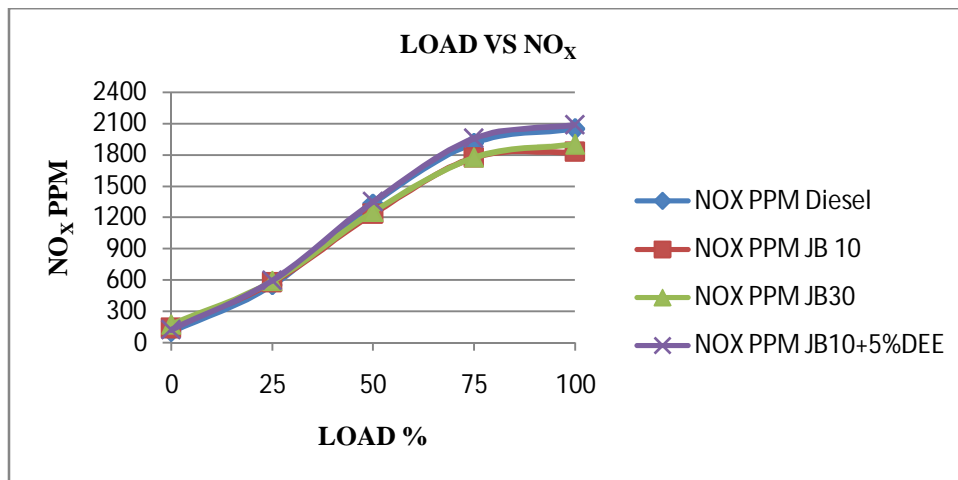
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### 4.NO<sub>x</sub> Emissions :

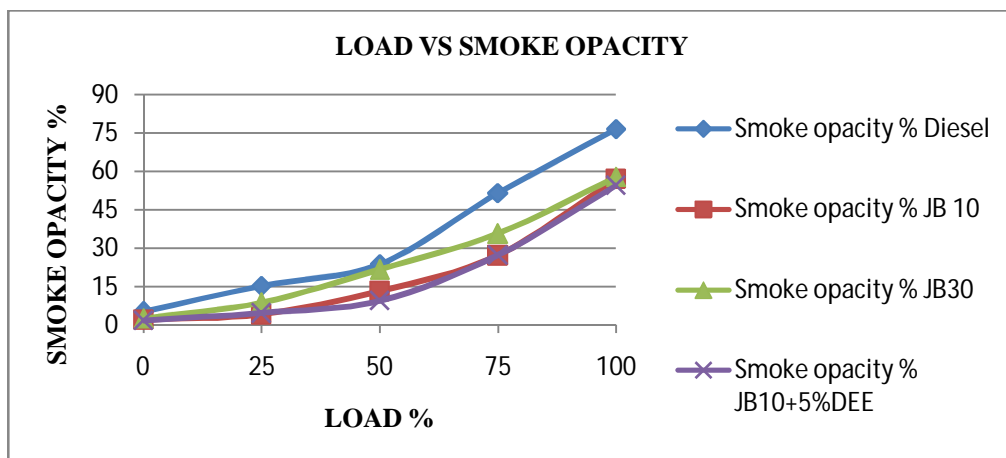
From the graph observed that the variation of oxides of Nitrogen for various blends with respect to diesel is shown in figure. It is observed that NO<sub>x</sub> emission of JB10 is low when compared with other biodiesels blends at all loads. Because of anti-oxidant property of the Jamun which reduces the emissions. By adding Di Ethyl Ether to JB10 NO<sub>x</sub> slightly increases compare to other blends because of oxygenated additive having high oxygen content.



(g)

### 5.Smoke Opacity :

From the graph observed that JB10 and JB10+5% DEE showed much lower smoke emission. Because of proper combustion of fuel. The smoke emission is mainly affected by the heterogeneous of diesel combustion and air-fuel ratios. Smoke formation primarily occurs in at higher temperatures if the fuel is partially oxygenated.



(h)

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## IV. CONCLUSION

In this present work the results of JB10 and JB30 shows better Brake thermal efficiency and specific fuel consumption compare to diesel. The Emissions like CO<sub>2</sub>, NO<sub>x</sub> and smoke opacity are reduced compare to diesel. HC and CO are highly increased. Further we add 5% of Diethyl Ether to JB10 HC and CO decreased compare to diesel and slightly increased in NO<sub>x</sub> and shows better efficiency.

From the detailed experimental study, it is concluded that Jamun bio diesel blends can be used as alternative fuel effectively in diesel engine without any engine modifications on the basis of performance and environmental emissions. Hence Jamun biodiesel could be a potential substitute for conventional diesel.

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