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**Research Article**

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# Emission characteristics of a CI engine with the addition of kamala orange skin additive

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**ABSTRACT**

*In Indian cities automobile pollution has reached intolerable limits. The vehicular population is continuously increasing and pollution is increasing rapidly. The temperature keeps rising due to the pollution .The presence of carbon dioxide in the atmosphere increases the temperature. The objective of the present study is to investigate the effects of petro diesel and biodiesel blends on the emission characteristics on a four stroke single cylinder diesel engine when biomas additive is added. Biodiesel fuel used in the study was prepared from goat and sheep fats. The fats were collected from meat stalls in and around Hosur town of Krishnagiri District, Tamil Nadu, India. Biodiesel is produced by the transesterification process and subsequently the kamala orange skin additive is blended with the petro diesel - biodiesel blends .The additive is added in varying proportions. The kamala orange skin additive is used to solve some technical problems generated by the use of petro diesel – biodiesel blends. The results showed a reduction of 11.8% NOx, 9.5% HC, 91% smoke and no significant reduction in CO when biomass additive B20 + 30 mL was used as fuel.*

**Key words**: fats, bio diesel, transesterification, kamala orange additive and emission.

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## INTRODUCTION

Biodiesel is a new , renewable and biological origin alternative fuel and recently it has been receiving more attention all over the world. The increasing industrialization and motorization of the world has led to a steep rise for the demand of petroleum products [1]. The engine does not require any modification to use biodiesel as fuel. Plant oils were used as fuel in IC engines without any modification before 1912 [2]. Biodiesel ,known as the mono alkyl esters of vegetable oils or animal fats,is an attractive alternative fuel due to its environmental friendly nature [3].It can also be synthesized from edible and non edible oils[4].

The main advantage of biodiesel is that it potentially reduces the key pollutants, carbon monoxide, unburnt hydrocarbons and particulate matters. Biodiesel produced from saturated feedstock reduces NOx emission and resistive to oxidation but it exhibits poor atomization [5]. Coconut ,palm and tallow contains high amounts of saturated fatty acids[6]

Vegetable oils can be seen as a renewable fuel source for diesel engines .However , their viscosity is higher than that of diesel fuel. Transesterification process was used to reduce the viscosity of vegetable oil. Biodiesel is a clean burning alternative fuel produced from renewable resources [7]. However ,it is susceptible to oxidative degradation due to its auto oxidation in the presence of oxygen , which prevents its widespread use. Anti-oxidant addition is a prospective solution to this problem .The two antioxidants (2,6-di-tert-butyl-4-methyl phenol and 2 ( 3 ) – tert – butyl – 4 - methoxy phenol ) reduce NOx by a mean of 9.8 – 12.6 % compared to B20[8].

India is an agricultural country and produces lot of kamala oranges .These oranges are brought to the markets in the cities .The disposal of orange peels becomes a problem .An experiment was done by mixing orange peels powder with biodiesel directly in the diesel engine. From the experiment it was observed that the engine using biodiesel soaked in orange peels released less emissions.

## EXPERIMENTAL SECTION

**Collection of feedstock**
Waste animal (goat & sheep) fat was obtained from meat shops in and around Hosur Taluk, Krishnagiri District, Tamilnadu, South India. It was cooked in a vessel to remove the moisture. The temperature was gradually increased to 80˚C to extract the oil from the fat. The hot oil was strained in a white cloth to remove the residue. The oil obtained was converted to biodiesel by the transesterification process.

**Preparation of biomass additive:**
Orange peels was dried for two weeks to remove the moisture .The dried peels was ground into fine powder. 300 grams of kamala orange peels powder is soaked in 700grams of biodiesel (B20).The whole mixture is kept in a safe place for 20 days. Then the solution is separated from the precipitate by squeezing in a filter paper. The solution obtained was equal to 730grams and is abbreviated as Or.

**Table 1: Specifications of Engine**

| | |
|---|---|
| Make | Kirloskar |
| No of cylinders | Single |
| Cooling | Water |
| Fuel | Diesel |
| Speed | 1450-1550rpm |
| HP | 5HP |
| Starting | Crank |
| Lubrication | Forced |
| Bore(mm) | 80 |
| Stroke(mm) | 110 |
| Compression ratio | 16.7 :1 |
| **Type of Dynamometer** | Powermag |
| Cooling | Air |
| Load measurement method | Strain gauge |
| Max speed | 3000rpm |
| HP | 5HP |
| Coupling Type | Direct |

An experimental study was conducted on a single cylinder, four stroke diesel engine. The general specifications of the test engine are shown in the table 1. A kirloskar type standard engine test bed which consists of an electrical dynamometer was used. The electrical dynamometer is a swinging field direct current (DC apparatus rated for 3.75kW.The engine's speed was measured with a magnetic pickup sensor. The schematic view of the test equipments is shown in figure 1.Diesel fuel flow was measured with a high precision electronic balance. Exhaust gas temperature and lubricating oil temperatures were measured with a multipoint electronic temperature indicator. The thermocouples used were NiCr-Ni type which can measure upto 1200˚C.

An AVL DI GAS 444 Gas Analyzer was used to determine the percentage of carbon monoxide, hydrocarbon, carbon dioxide, oxygen and nitrogen oxides. The engine was allowed to run for several minutes to attain the steady state conditions. After attaining steady state conditions, the probe is inserted into the exhaust pipe of the engine. The exhaust gas flows over the reactor in the gas analyzer. The analyzer attained the steady state condition and the different values of the gases are displayed. An AVL437 smoke meter was employed to determine the smoke intensity. The readings are displayed on the monitor of the smoke meter.

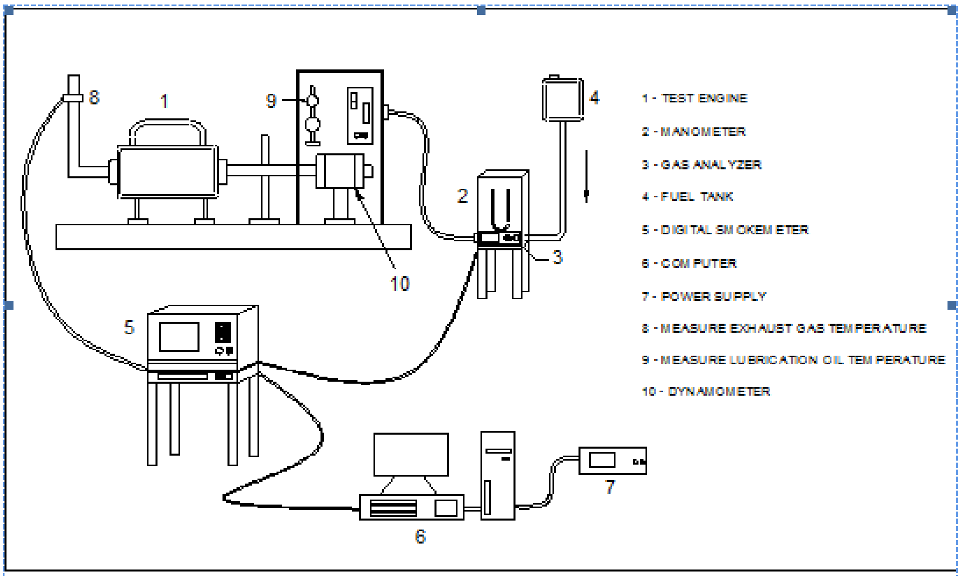


**Fig 1. Schematic of the Experimental Setup**

Blends of animal fat (goat & sheep) based biodiesel fuel B20 (B20 – blended in volume at the ratio of 20% with diesel fuel) and petro diesel fuel were used in this experiments . Five fuel samples were prepared . They are 1000mL of petro diesel,1000mL of B20,1000mL of B20 + 10mL of additive , 1000mL of B20 + 20mL of additive , 1000mL of B20 + 30mL of additive .The additive used is orange peels powder soaked in biodiesel. Experiments were conducted at different load conditions at constant speed (1500 rpm).Before each test, the engine was warmed up with diesel fuel. Engine oil temperatures were kept stable around 80˚C.The parameters like CO , $NO_x$ , HC and smoke intensity were noted at different load conditions (20%,40%,60%,80% & 100%) for each sample .

## RESULTS AND DISCUSSION

The evaluation of exhaust emissions on the single cylinder diesel engine was done.

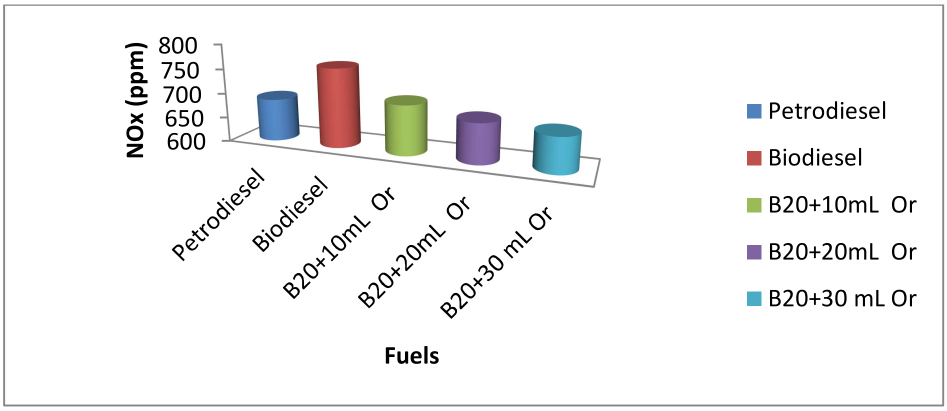


**Fig 2. Comparison of NOx emissions among Petrodiesel and the biofuel blends**

The variation of NOx emissions with respect to load is shown in Fig. 2. It is observed that the use of B20 fuel increased NOx emissions by 10%. The use of biodiesel results in higher NOx emissions, due to its high cetane number. As biodiesel contains more oxygen, it improved fuel oxidation during combustion which resulted in higher local temperatures [9-11] . Thus, NOx emissions were increased by a thermal formation mechanism. The cleaning up of free radicals during combustion either reduces or eliminates NOx . Antioxidants are known as free radical cleaning agents. Fig. 2 shows that NOx has been reduced to an extent of 11.8% by B20 + 30 mL of Or. The reason for reduction of the NOx emissions is due to the increase of cetane number of fuels.

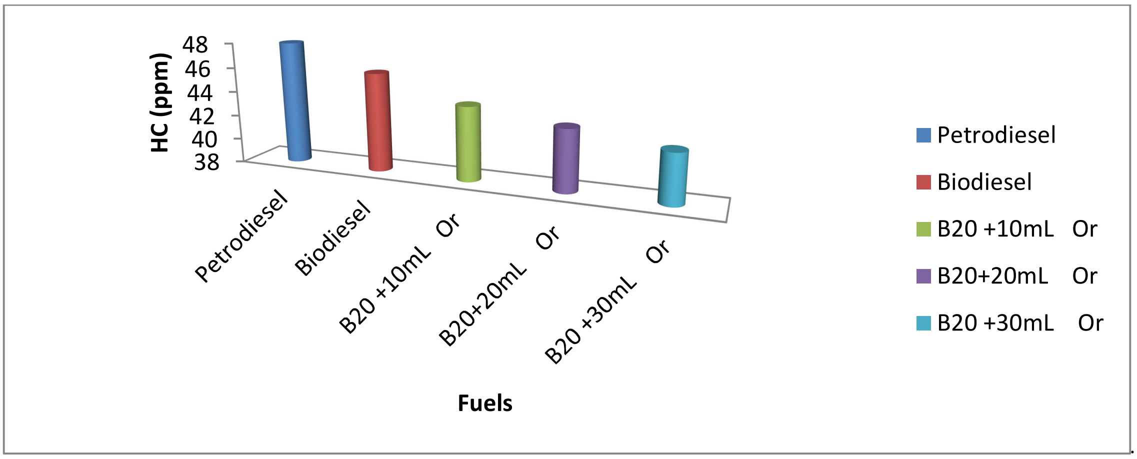


**Fig 3. Comparison of HC emissions among Petrodiesel and the biofuel blends**

Fig. 3 shows the variation of hydrocarbon emissions with respect to load of different fuels. Since biodiesel is an oxygenated fuel, it improves the combustion efficiency and reduces the concentration of hydrocarbon (HC) emissions in the engine exhaust. Blending 30 mL of orange peels powder soaked in biodiesel (Or) to B20 (blended with 20% by volume of biodiesel from goat and sheep fats and 80% by volume of petro diesel) reduces HC emissions by 9.5%.The hydrocarbon emission is found to be lower with the increase of antioxidant fraction in the blends.

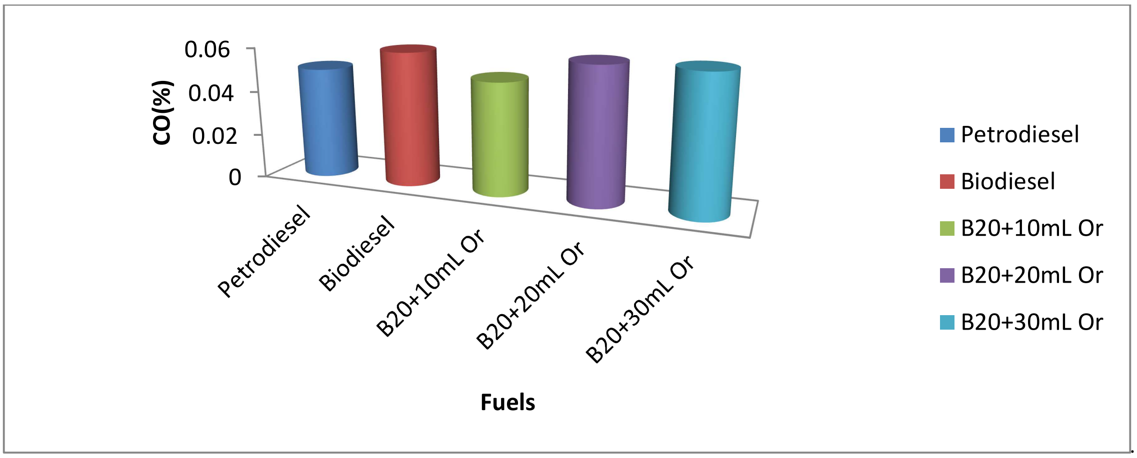


**Fig. 4. Comparison of CO emissions among Petro diesel and the biofuel blends**

Fig. 4 depicts the variation of carbon monoxide emissions (CO) with respect to load of different fuels. Factors causing combustion deterioration due to high latent heats of evaporation are responsible for the increased carbon monoxide (CO) emission. The delay in the ignition also produces high CO emissions. This leads to a lower combustion temperature at lower loads. B20 + 10 mL Or produces the same amount of CO as petro diesel. Other fuels produce more amount of CO than petro diesel. It is possible that the oxygen contained in the fuel enhances complete combustion in the cylinder and reduces CO emission [12, 13].

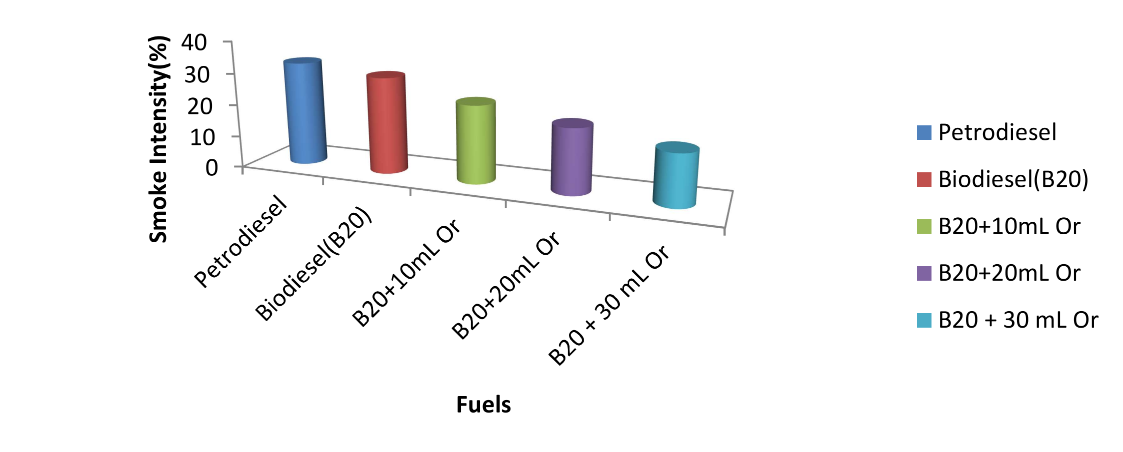


**Fig. 5.Comparison of Smoke intensity among Petro diesel and the biofuel blends**

Fig.5 depicts the variation of smoke emissions of different fuels. Since biodiesel is an oxygenated fuel, it produces less smoke than petro diesel. It is due to proper combustion of the fuel. It is observed that smoke emissions were reduced by 91% using B20 + 30 mL Or.

## CONCLUSION

The effect of petro diesel, biodiesel blend and the addition of additives to the biodiesel blend on the CI engine's emission (Smoke density, HC, NOx, and CO) characteristics were studied in detail for steady state operation conditions. The following conclusions are drawn from the experiments:

1. NOx has been reduced to an extent of 11.8% by B20 + 30 mL of Or .
2. Blending 30 mL of orange peels powder soaked in biodiesel (Or) to B20 (blended with 20% by volume of biodiesel from goat and sheep fats and 80% by volume of petro diesel) reduces HC emissions by 9.5%.
3. Biodiesel an oxygenated fuel, produces less smoke than petro diesel.
4. B20 + 10 mL of Or produces CO similar to petro diesel. Other fuels produce CO more than petro diesel.

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