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Research Paper

Investigation of the Performance and Emission Characteristics of Biodiesel-Diesel Blends in Direct Injection Diesel Engines

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Abstract

The emission and performance attributes of a mono-cylinder direct injection variable compression test engine were explored using Jatropha curcas as a feedstock for biodiesel production. Two-step techniques, esterification and transesterification, were employed to create biodiesel with diesel fuel-like properties. In the first phase of esterification process, the molar ratio of methanol to the parent oil Jatropha curcas was 1:6, and 1% volume of sulfuric acid was added. The mixture temperature was maintained at 65 degrees Celsius, and the magnetic stirrer on the hotplate was adjusted to 600 rpm. At this point, the acid value decreased from 4.6mg-KOH/g-oil to 1mg-KOH/g-oil. During the second transesterification procedure, the catalysts were sodium hydroxide pellets and analytical-grade methanol at the same stirring speed and mixture temperature for 25 minutes. The emission as well as performance characteristics of biodiesel-diesel blends containing various mixing ratios were studied. The test samples B_{20}, and B_{100} produced less carbon monoxide and hydrocarbon as compared to the baseline diesel fuel, and the power, and torque outputs of B_{20} were superior to all blends. The unexpected conclusion of the study was that increasing the blend's biodiesel component increases braking power and torque while decreasing brake-specific fuel consumption.

1. Introduction

Energy is currently an important aspect for human beings (Atabani et al., 2012; Rehman et al., 2019). Currently, the transportation sector consumes a huge amount of fossil fuel and emits a large amount of CO_2 (Wang et al., 2014). Diesel fuel is expected to meet 60% of the overall energy supply demand in 2035 (Chhabra et al., 2021). The world's energy demand has compelled numerous researchers to pursue alternative energy solutions (Akram et al., 2022; Bibin et al., 2023; Hwang et al., 2014). Because of the recent high and erratic oil prices, different governments were forced to create unique measures to reduce the impact of these high costs on their economy. Ethiopia's energy demand is rising quickly because of the country's expanding economies and infrastructure. However, Ethiopia, imports all of its petroleum fuel needs to meet the ever-increasing national demand for energy.

As a result, when it comes to alternative energy solutions, biodiesel appears to provide the best prospects (A. Demirbaş et al., 2015; A. H. Demirbaş et al., 2015). Ethiopia's biodiesel production has the potential to provide several benefits (Amigun et al., 2011; Birhanu & Ayalew, 2017). Oilseed crops are used to produce biodiesel fuel to propel IC engines (Chidambaranathan et al., 2020; Dimian & Rothenberg, 2016). In this study, Jatropha curcas was

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chosen for biodiesel production due to its local availability, high non-edible oil content, and the capacity to grow everywhere (Bailis & Baka, 2010; Suhana Mokhtar et al., 2021). Jatropha curcas oil content ranges from 30% to 50% of seed weight (Kumar Shukla et al., 2020).

Biodiesel has a higher density and viscosity for diesel engines (Chen et al., 2013). Depending on the amount of free fatty acid profile, either esterification or transesterification is required. These reactions are aided by the inclusion of a base catalyst (Anastopoulos et al., 2009). Biodiesel have a bigger droplet size, which contributes to poor combustion (Demirbaş et al., 2016). However, this fuel possesses physio-chemical properties similar to diesel oil, which improves fuel efficiency, and lubricity, resulting in better engine life (Jha & Schmidt, 2021). Biodiesel has a greater cetane number (Taher et al., 2020) and because of its cloud point, it diminishes performance in cold areas(Travis, 2012). The performance of biodiesel is investigated by (Rao et al., 2008) and the fatty acid groups like linoleic and oleic split into smaller compounds to form large spray angles. The decomposition of linoleic and oleic into smaller compounds causes advanced injection timing (Bibin, Devan, Senthil Kumar, Gopinath, & Sheeja, 2021; Bibin, Devan, Senthil Kumar, Gopinath, Sheeja, et al., 2021).

The combustion behaviours of biodiesel-diesel blends are studied by (Ozsezen et al., 2009). Accordingly, the performance of methyl ester has a lower heat release rate and cylinder pressure compared to diesel fuel. The emission and combustion efficiency of olive oil methyl ester and diesel fuel (Dorado et al., 2003). However, the olive methyl ester significantly reduced CO, NO_x, and CO_2 by 58.9%, 32%, and 8.9%, respectively. Similarly, adding nanoparticles reduces HC, CO, CO_2, NO_x, and smoke while increasing excess O_2 were studied by (El-Seesy et al., 2020; Mujtaba et al., 2020; Sai Kiran et al., 2021; Soudagar, 2020; Soudagar et al., 2018; Venu et al., 2021). As Jatropha, curcas is available and with reasonable oil content, its suitability has to be studied for the propulsion of diesel engines.

The goal of this research is the synthesis of Jatropha curcas methyl ester, characterization of biodiesel-diesel blends, and comparative study of biodiesel-diesel blends against the baseline diesel fuel to investigate the emission & performance behaviours in TD43F test engines.

2. Materials and Methods

The materials for this research were Jatropha curcas seeds, analytical grade methanol, n-hexane, anhydrous potassium sulphate, and filter paper. The research method was experimental, involving extraction of oil, transesterification, characterization, and testing emission and performance behaviour in the TD43F test engine. The fatty acid analysis of Jatropha oil methyl ester was conducted using a Varian 3800 model GC equipped with an FID detector. A Varian CP-3800GC equipped with a DB-5 column and FID detector was used for the fatty acid analysis. The free fatty acid composition of Jatropha Curcas oil was detected by gas chromatography (Model Varian 450 GC). The physicochemical properties of the oil after transesterification were tested by the ASTM D6751 test method. Minitab 22 software was used for the analysis and interpretation of the data of the experiment.

2.1. Determination oil yield

The oil yield was calculated as shown by the equation below.

$$\%\,Oil\ yield = \frac{W_1 - W_3}{W_2}\,\% \qquad \text{……………. (1)}$$

Where: W_1 = Original weight of the sample,

W_2 = Weight of pre-extraction dried sample + filter bag

W_3 = Weight of dried sample + filter bag after extraction

2.2. Experimental setup

The experiment was carried out using a TD43F variable compression engine test rig model TOOLQUIP 5000, which was outfitted with an engine dynamometer, air tank, airflow meter, exhaust gas analyzer, fuel tank smoke tester, fuel flow meter, and dashboard for measuring engine torque, power, and rpm.

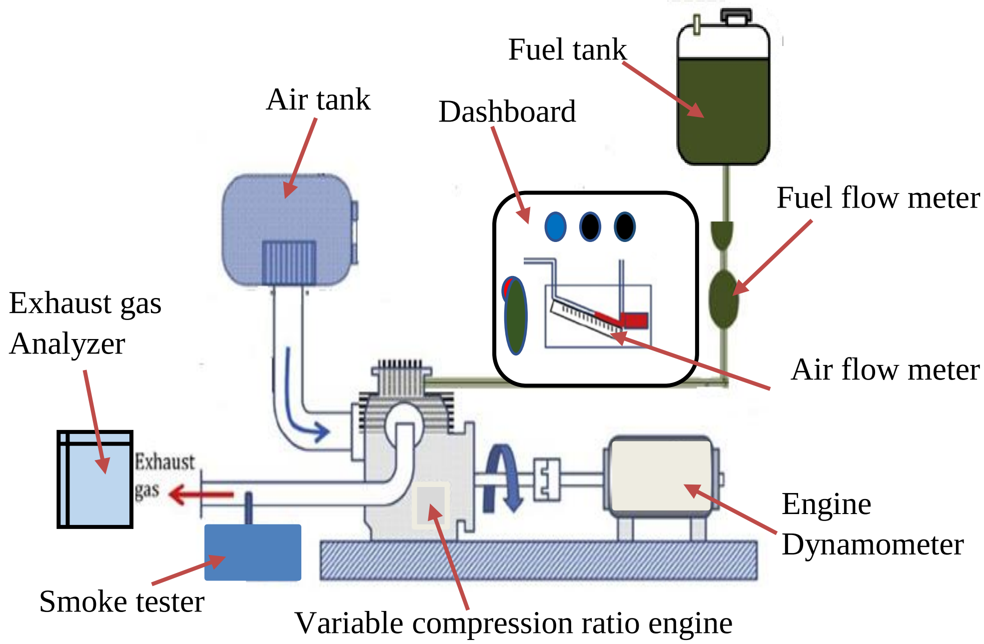

Figure 1: Schematic representation of the experimental setup

The specifications of the tested engine are indicated in Table 1.

Table 1. Test engine specifications

No. of cylinder	1
Bore, mm	95
Stroke, mm	85
Connecting rod length, mm	156
Capacity, cc	582
Maximum speed, RPM	3000
Engine type	Four-stroke naturally aspirated
Compression ratio	5:1-18:1
Injection timing, deg. BTDC	20
Maximum power, KW	9.5
Maximum torque, Nm	45
Cooling type	Water cooled

The experiment was conducted at selected seven engine speeds (1000, 1250, 1750, 1500, 2000, and 2500 rpm) with a compression ratio of 1:14 and a 20^0 crank angle BTDC. The compression ratio of diesel engines ranges from 1:14 to 1:25. Hence, the variable compression test engine was adjusted to 1:14 to seek lower emissions of nitrogen oxides (NO_x), soot, and combustion temperature. Moreover, it increases the fuel-air premixing time (Vikraman et al., 2021). The fuels used in this experiment were, diesel number 2 as reference and diesel-biodiesel blends of B_5, B_{10}, B_{20}, B_{40}, B_{80}, and B_{100} were investigated for their emission and performance characteristics.

2.3. Experimental design

In this study, Minitab 22 software was used for full factorial design with seven levels and two factors with 49 possible combinations to analyze the interaction of engine speed and biodiesel-diesel blends for the response of engine performance and emission. The factors and their respective levels are listed in Table 2.

Table 2. Experimental design

Factor	**Levels**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Blend ratio	B_0	B_5	B_{10}	B_{20}	B_{40}	B_{80}	B_{100}
Speed	1000	1250	1500	1750	2000	2250	2500

3. Results and Discussion

The oil extraction yield, fatty acid profile test, esterification, transesterification process, combustion, emission, and performance parameters are all covered in this section. The extracted oil yielded 22% (v/w) and 33.3% (v/w) for solvent and a combination of mechanical press and solvent methods, respectively. Mechanical extraction produces a better yield while also being more cost-effective and time-efficient. The fatty acid profile of oil was determined before the synthesis of biodiesel. Table 3 summarizes the findings of the fatty acid assessments. The free fatty acid content was determined to be 4.6%, causing saponification. As a result, a two-step esterification and transesterification process was carried out, as other researchers had done (Bibin et al., 2022). The acid value fell from 4.6mg-KOH/g-oil to 1mg-KOH/g-oil during the esterification process. The production of Jatropha methyl ester was 97% volume and the yield of glycine was 18.75% volume of the crude oil trans-esterified throughout the transesterification process. The FTIR test was used to examine the outcome of the transesterification reaction. The Jatropha oil was analyzed and monitored by the intensity of C=O ester stretch at wave number (1742cm-1) assigned to the ester group (Lamichhane et al., 2020), which revealed a strong ester, indicating the generation of biodiesel as indicated in Figure 2.

Table 3. Fatty acid profile of Jatropha Curcas

Oilseed	Palmitic acid (C16:0)	Stearic acid (C18:0)	Oleic acid (C18:1)	Linoleic acid (C18:2)	Linolenic acid (C18:3)
Jatropha oil	6.1	3.9	52.8	33.6	3.3

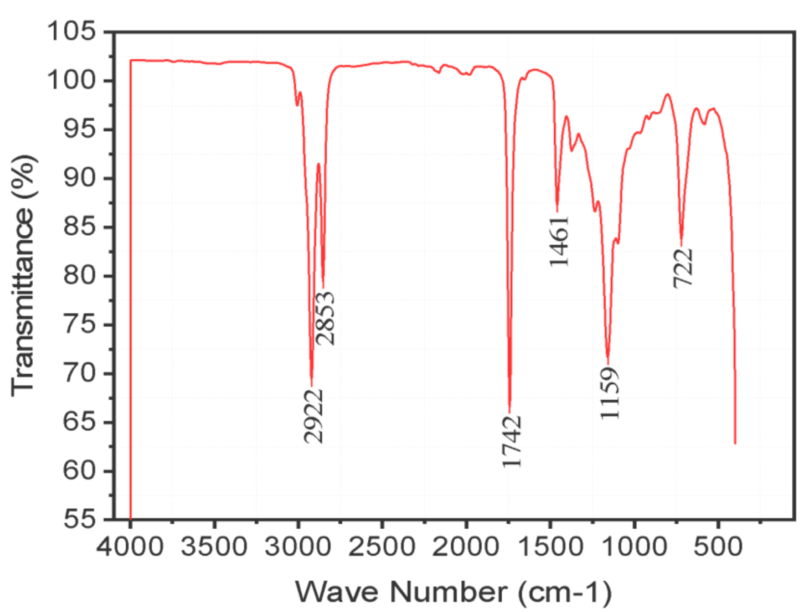

Figure 2. FTIR test result of Jatropha methyl ester

3.1. Results of the blends of physio-chemical properties.

According to the ASTM D6751 standard, the physio-chemical properties results of the oil were in the standard range, which defines the oil to be biodiesel as shown in Table 4. The flash point of biodiesel is 173.80ºC, which is higher than the flash point of pure petro-diesel, which is 71.80ºC. As a result, biodiesel is less susceptible to fire hazards than fossil fuels during storage and fuel custody transfer. The cetane indexes of biodiesel and diesel fuel were 47.13 and 52.9, respectively. As a result, for proper combustion, biodiesel requires more advanced injection timing than diesel fuel. Compared to other blends, B_{20} and B_{40} have higher cetane indexes, which indicate that B_{20} and, B_{40} fuel blends burn quickly and yield better performance. The cloud point of biodiesel is 7 ºC, which is higher than pure diesel fuel with a cloud point of 0ºC. This biodiesel can be used in a climate with a temperature above 7 ºC without engine modification. Moreover, it is safer for storage and handling because biodiesel is denser than petro-diesel with a density of 0.8812 and 0.8440g/ml respectively. The initial boiling point of the biodiesel produced from Jatropha carcus (neat biodiesel) and diesel fuel are 298ºC and 176ºC respectively. Therefore, biodiesel has a higher initial boiling point that affects the starting of engines at lower temperatures and which causes higher fuel consumption during starting.

Table 4. Parameters of the oil samples after characterization

NO	PROPERTY	TESTS ASTM	LIMIT 6751-07B	TEST RESULT						
				B_{100}	B_{80}	B_{40}	B_{20}	B_{10}	B_5	B_0
1.	Density@15⁰c,g/ml	D1298	Report	0.8842	0.8786	0.869	0.8556	0.8616	0.8496	0.8474
2.	Density@20⁰c,g/l	D1298	Report	0.8812	0.8753	0.855	0.8522	0.8582	0.8462	0.8440
3.	Distillation% V	D86	-	-	-	-	-	-	-	-
	IBP⁰C		-		188.5	184.5	182.5	184.5	177.5	176
	10%, recovered		-		331.5	228	217	215	214	220
	40%recovered		-	335	331.5	302	281.5	275.5	268	282.5
	50%recovered		-	336.5	333.5	316.5	298	287.5	282.5	292.5
	90%recovered		Max360⁰C	343.5(83%)	343	356	49	349	343	349
	95%recovered			-	349	364.5	361	366.5	364	352
	100%recovered			-	-	-	-	-	-	-
	FBP		Max390	343.5	349	367.5	362	366.5	370.5	352
4	Flashpoint(PMCC)	D93	100M	173.8	102.8	78.8	76.8	74.8	72.8	71.8
5.	Cu-Strip-corrosion	D130	Max3	1b	1a	1a	1a	1a	1a	1a
6.	Cloud point, ⁰C	D2500	Report	+7	+6	0	- 1	- 1	- 1	0
7.	Pour point, ⁰C	D97	Repot	< - 3	< - 5	< - 8	< - 8	< - 8	< - 8	< - 8
8.	Kinematic viscosity	D445	1.9__ 6	5.12	4.694	3.828	3.5116	3.2865	3.2013	3.1637
9.	Cetane Index	D976	Min47.0	47.13	48.5	51.34	51.127	47.56	50.46	52.905
10	ASTM color	D1500	Max =3	1.5	1<x1.5	1<x<1.5	1<x<1.5	1<x<1.5	1<x<1.5	1
11	Water, seg In, %V	D2709	Max0.03	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
12	Acidity, mg KOH/g	D974	0.5	0.1686	0.2035	0.113	0.0534	0.0327	0.02136	0.0106
13	Ash content, mass%	D482	Max0.01	0.0019	0.0012	0.006	0.0006	0.0006	0.0006	0.0001
14	Calorific value, Cal/g	__	Report	9,633.06	9,808.9	10,31.13	10,619.4	10,696.18	10,800.35	11,111.3

3.2. Combustion Characteristics

The combustion properties of biodiesel-diesel blends are affected by cylinder gas pressure, heat release rate, and ignition delay duration, all of which can be used to compare combustion performance (Bibin et al., 2020). The peak cylinder pressure for blend B_{80} was 52 bar, as shown in Fig.3a. The presence of oxygen molecules in biodiesel and hydrocarbons results in improved combustion and increased cylinder pressure (Canakci & Van Gerpen, 2003). A study conducted with biodiesel-diesel blends showed an ignition delay due to higher viscosity, low volatility, and higher cetane number of the biodiesel blends as shown in table 4. As a result, combustion for diesel fuel began later, and peak cylinder pressure was lower as it moved further away from the TDC during the expansion stroke. The inclusion of oxygen molecules in biodiesel allows the hydrocarbons to burn with greater effectiveness, resulting in increased cylinder pressure (Soundararajan et al., 2022).

Equivalence ratio: Diesel combustion and emission are characterized by an overall A/F ratio. To avoid excessive smoke generation, the lowest average A/F ratio is frequently seen under peak torque situations exceeding 25:1. However, for diesel engines, the stoichiometric air-fuel ratio is around 14.4:1, which is determined in a mole or mass base by dividing the actual fuel-air ratio by the theoretical fuel-air ratio. The equivalence ratio for stoichiometric combustion is 1 and if it is less than 1, the combustion is lean. If the ratio is larger than 1, the combustion is rich with incomplete combustion (Heywood, 2018). Fig.4 depicts the effect of the equivalence ratio at various engine speeds and biodiesel-diesel mixtures.

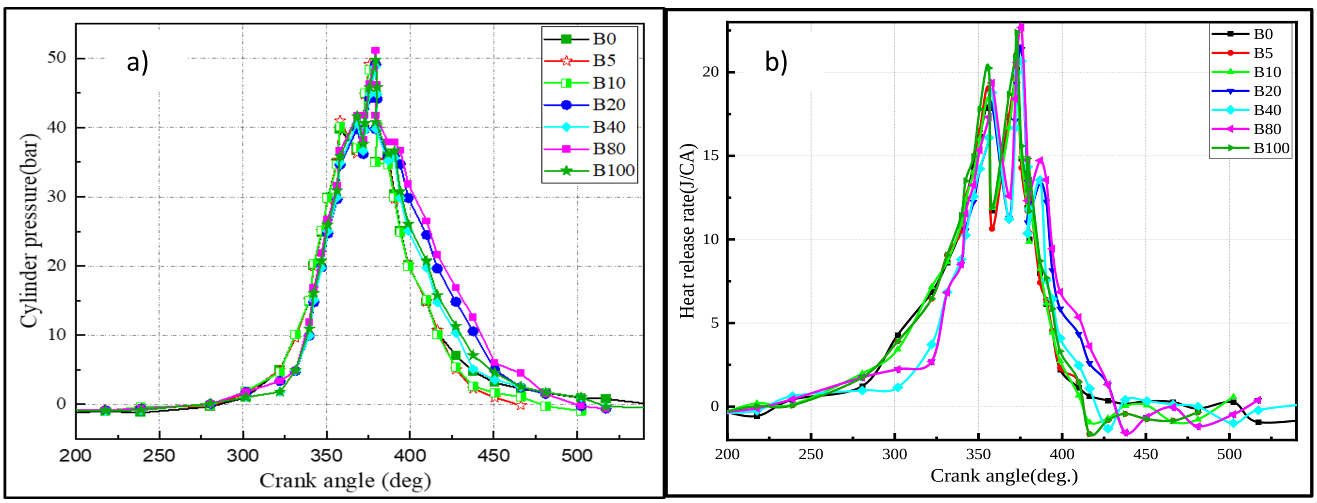

Figure 3. a) Cylinder pressure b) heat release rate vs. crank angle

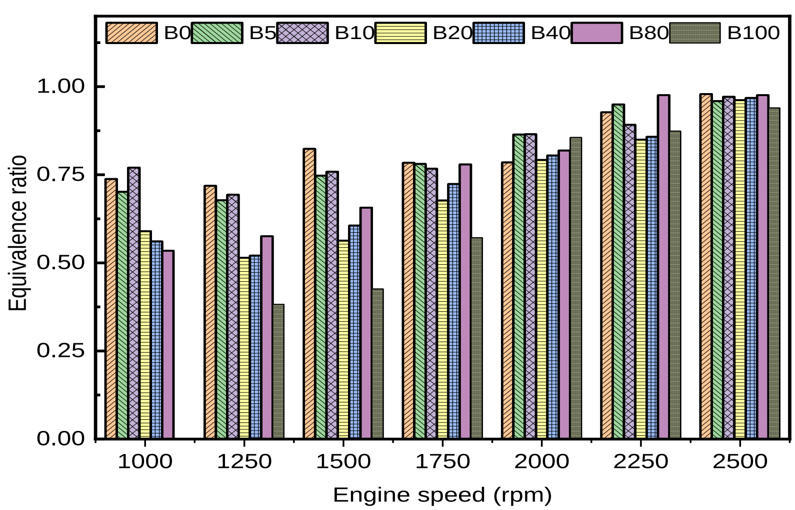

Figure 4. Equivalence ratio vs. engine speed

According to Fig.4, as engine speed rose, the equivalency ratio for all biodiesel-diesel blends increased significantly. The equivalency ratio for all biodiesel-diesel blends declined as the percentage of biodiesel in the blends rose. Furthermore, when the equivalency ratio grew, the hydrocarbon emission increased for all biodiesel-diesel blends. Near the unity equivalency ratio, carbon monoxide and nitrogen oxide emissions were highest.

3.3. Evaluation of the emission of diesel-biodiesel blends

This study looked at CO, HC, CO_2, and NO_x emission characteristics of biodiesel-diesel blends. As seen in Fig. 5a, as the biodiesel ratio increases, the concentration of CO emissions decreases through the engine speeds except for the blends B_{40} and B_{80} at higher engine speeds. As the engine speed increases from 1500 rpm-2500 rpm, the CO emission of B_{100} increases from the baseline fuel because; its combustion time is shorter than the reference fuel. At higher engine speeds, B_{20} emitted less than baseline diesel fuel from 1750 rpm to 2500 rpm. The concentration of CO_2 emissions increased somewhat as the proportion of biodiesel in the blend increased, as seen in Fig. 5b, with blends B_{20} and B_{40} having the highest concentrations of CO_2 emissions. This is due to the presence of oxygen in the biodiesel blends, which promotes good combustion. These findings were consistent with the findings of some previous studies (Gad et al., 2018; Ibrahim et al., 2014). Apart from the oxygen, the content of the fuel and other physio-chemical characteristics such as viscosity determine the fuel droplet size that results from the variation of combustion species of gasses. Even though B_{40} is superior to B_{20} in oxygen content, the blend B_{20} showed better combustion performance for the specified engine operating characteristics.

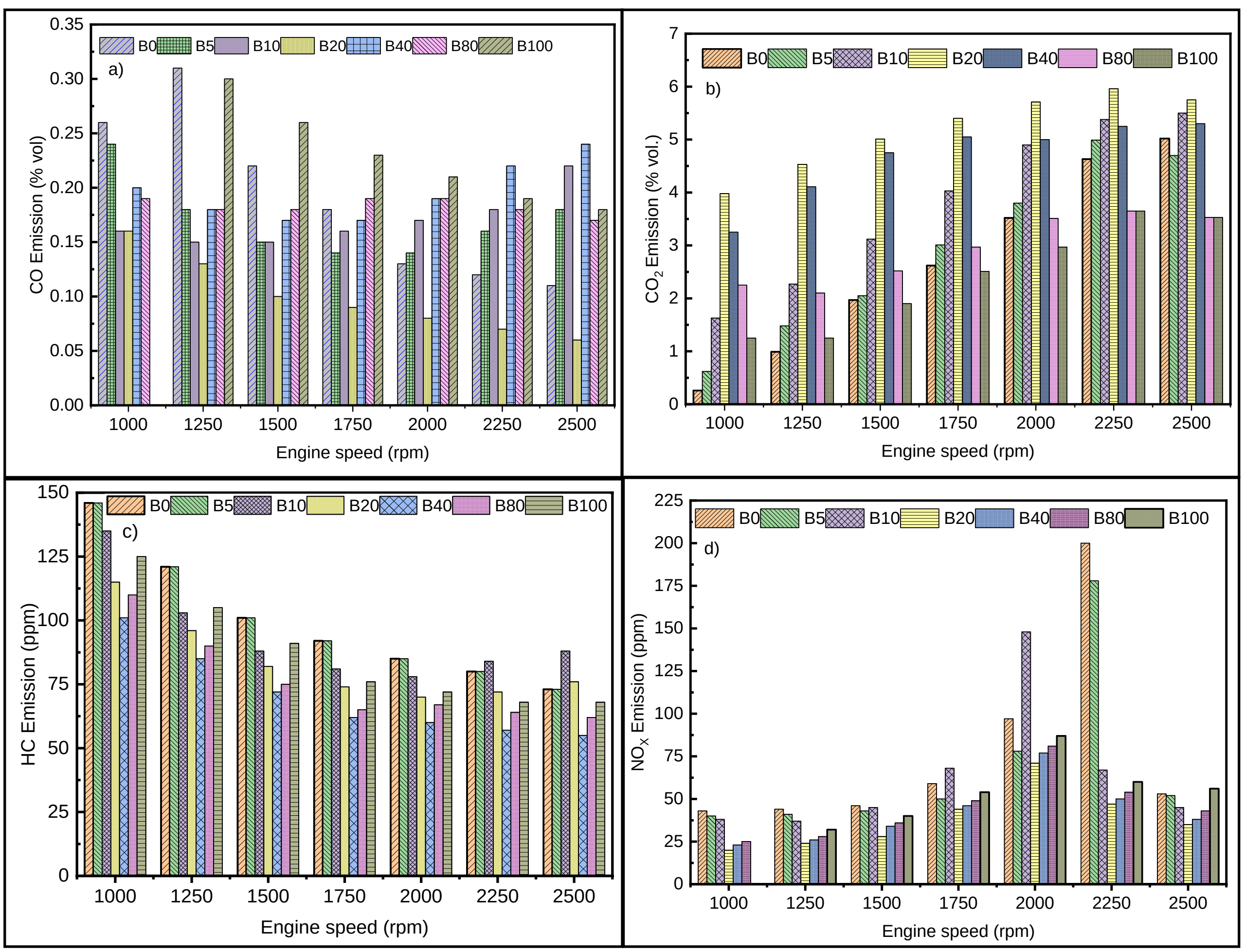

Figure 5. Emission of, a) CO b) CO_2 c) HC d) and NO_X vs. Engine speed

Figure 5c depicts the effect of engine speed on unburned hydrocarbon emissions. The emission of HC concentration decreased as the percentage of biodiesel in the blends increased except for B_{10} at the maximum engine speed, as seen in the previous study (Ganapathy et al., 2011). Furthermore, when the engine operated from its rated idle speed to its maximum speed, HC emission was reduced for all types of mixes. The blends B_{20}, B_{40}, and B_{80} released the least amount of HC between 2000 and 2500 rpm. The greatest NO_x concentration was measured between 1775 and 2275 rpm. Furthermore, when the biodiesel blend ratio grew, so did the NO_x concentration, as seen in the graph in Figure 5d, and this conclusion was validated by (Devkota & Adhikari, 2021; Joshi & Adhikari, 2021).

3.4. Evaluation of Engine performance

The power and torque curve patterns of the fuel blends (B_0, B_5, B_{10}, B_{20}, B_{40}, B_{80}, B_{100}) versus speeds that looked to be similar to normal diesel fuel as depicted in Figs. 6a and 6b. Because of the lower calorific content of the biodiesel (Carraretto et al., 2004), power and torque are reduced slightly. According to a prior study, the effect of brake torque and engine speed follows a similar pattern. Because of the lower calorific value and higher viscosity of the biodiesel, brake power and torque fell as the amount of biodiesel in the blends increased.

This study produced comparable results to a previous study conducted by (Ganapathy et al., 2011). According to Fig.7b, the TFC of B_{100} was superior to all blends of the oil samples tested in this study, which ranged from 1250 to 2000 rpm. However, at engine speeds more than 2000 rpm to the maximum engine speed, B_{20} and B_{40} performed better. Similarly, as seen in Fig. 7a and 7b, the brake-specific fuel consumption and TFC graph followed the same trend as the performance graph.

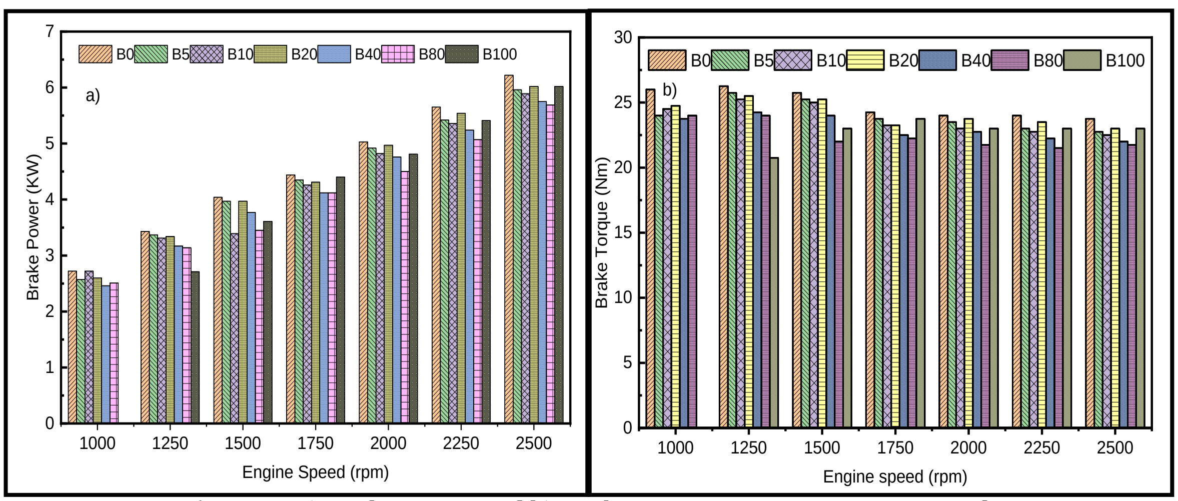

Figure 6: a) Brake power and b) Brake torque curves vs. engine speed

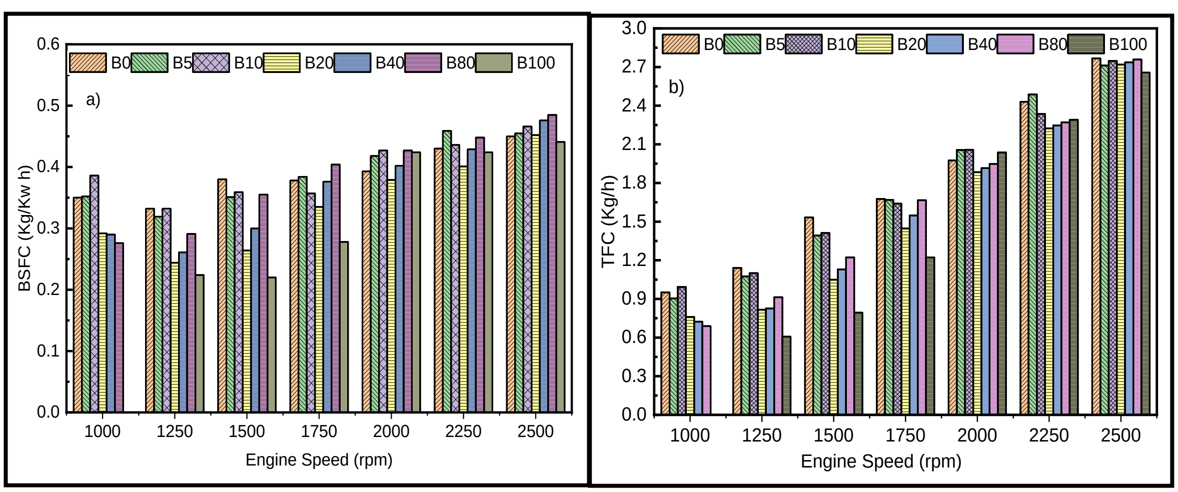

Figure 7: a) BSFC and b) TFC vs. Engine speed

In comparison with other diesel-biodiesel blends, the B_{100}'s brake thermal efficiency was greatest, in between 1200 rpm and 1700 rpm engine speed as shown in Fig.8a. However, across the engine operating range, B_{20} and B_{40} had higher engine thermal efficiency. According to a prior study, using Jatropha biodiesel boosts brake thermal efficiency when compared to diesel fuel (Ganapathy et al., 2011). As seen in prior research (Bibin et al., 2019; Bibin et al., 2020), the thermal efficiency declined as the fraction of biodiesel in the blends rose. As can be seen from Fig. 8b's mechanical efficiency, B_{20} performed better than all other oil blends in the experiment at lower engine speeds, from idle to 1200 rpm. However, at intermediate speeds, B_{100} has the lowest mechanical efficiency. The overall mechanical efficiency of all blends declined as the percentage of biodiesel increased. However, the mechanical efficiency grew from the speed range of 1000 rpm to 1250 rpm and showed good lubricating characteristics. As a result, biodiesel blends are appropriate for high-speed and constant-speed engines.

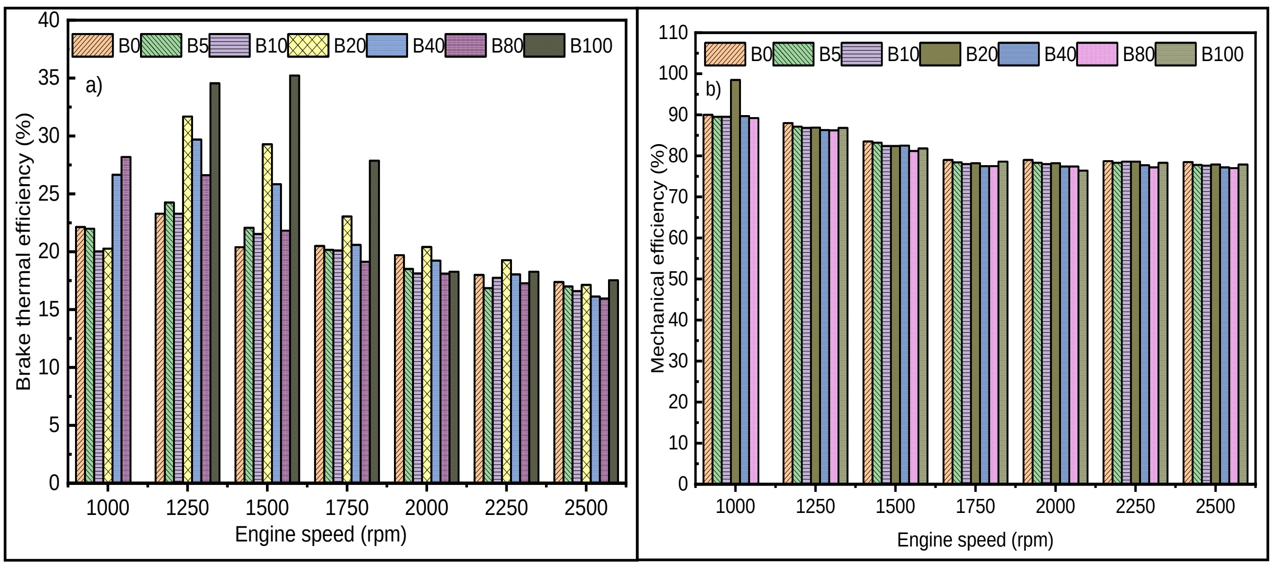

Figure 8: a) Brake Thermal b) mechanical c) Volumetric efficiency vs. engine speed

3.5. One Way ANOVA (Analysis of Variance) for F Test

The results of the ANOVA analysis in Table 5 showed whether there is a statistically significant difference between performance, efficiency, and emission characteristics.

CO had a significance value of (F (6, 42) = 0.472, p = 0.825, which was more than 0.05, indicating that the differences were not statistically significant. To determine whether a difference is statistically significant, it was observed the significance values for CO_2, NO_X, and HC were (F (6, 42) = 6.66, p = 0.00), (F (6, 42) = 6.599, p = 0.00), and (F (6, 42) = 18.749), respectively. As a result, the mean CO_2, NO_X, and HC levels differ statistically significantly for biofuel blends. Brake torque was not statistically significant between the biodiesel blends in terms of performance when (F (6, 42) = 0.717, p = 0.638) was higher than 0.05, indicating that there was no statistically significant variation in the mean torque values between the biofuel blends. The significance values for braking power, TFC, and BSFC were all less than 0.05 (F (6, 42) = 66.423, p = 0.00), (F (6, 42) = 104.643, p = 0.00), and (F (6, 42) =10.467, p = 0.00), indicating that the differences are statistically significant. As a result, there is a statistically significant difference across biofuel blends in the mean of brake power, TFC, and BSFC.

Additionally, there was no statistically significant difference in the mean volumetric and mechanical efficiency of the different biofuel blends (F (6, 42) = 0.736, p = 0.623), and (F (6, 42) = 0.804). While the mean thermal efficiency of the various biofuel blends varied statistically significantly (F (6, 42) = 5.246, p = 0.00), the difference was less than 0.05 for the biodiesel blends.

Table 5. ANOVA table for performance, efficiency, and emission characteristics

		Sum of Squares	df	Mean Square	F	Sig.
Brake torque	Between Groups	57.633	6	9.605	0.717	0.638
	Within Groups	563.000	42	13.405		
	Total	620.633	48			
Brake power	Between Groups	69.299	6	11.550	66.423	0.000
	Within Groups	7.303	42	0.174		
	Total	76.602	48			
BSFC	Between Groups	0.222	6	0.037	10.467	0.000
	Within Groups	0.148	42	0.004		
	Total	0.370	48			
TFC	Between Groups	23.246	6	3.874	104.643	0.000
	Within Groups	1.555	42	0.037		
	Total	24.801	48			
η_{th}	Between Groups	658.134	6	109.689	5.246	0.000
	Within Groups	878.117	42	20.908		
	Total	1536.250	48			
η_v	Between Groups	758.140	6	126.357	0.736	0.623
	Within Groups	7206.048	42	171.573		
	Total	7964.188	48			
η_m	Between Groups	514.208	6	85.701	0.501	0.804
	Within Groups	7190.169	42	171.194		
	Total	7704.377	48			
CO	Between Groups	0.010	6	0.002	0.472	0.825
	Within Groups	0.152	42	0.004		
	Total	0.162	48			
HC	Between Groups	17,381.061	6	2896.844	18.749	0.000
	Within Groups	6489.429	42	154.510		
	Total	23,870.490	48			
CO_2	Between Groups	54.477	6	9.079	6.660	0.000
	Within Groups	57.255	42	1.363		
	Total	111.732	48			
NO_X	Between Groups	30,958.980	6	5159.830	6.599	0.000
	Within Groups	32,841.429	42	781.939		
	Total	63,800.408	48			

4. Conclusions

- The study's goals included producing biodiesel and evaluating its performance and emission characteristics in four-stroke diesel engines that had not undergone any modifications. With a pre-set compression ratio of 1:14, the fuel injection time used in this research was 210 BTDC. To make biodiesel, solvents and mechanical pressing were used.

- With an average yield of 33.3%, the mechanical extraction method provides a greater yield, lower cost, and saves time.
- Glycerine, a by-product of biodiesel production, accounted for around 18.75% of the amount of biodiesel collected, making it a viable characteristic to provide to the cosmetic sector to raise money to cover production costs.
- Biodiesel has a greater flash point than diesel fuel, making it less prone to fire dangers and fuel custody transfer.
- The cloud point of biodiesel is 7^{0}C, which is higher than the cloud point of diesel fuel, which is 0 ^{0}C.
- Fuel usage and emissions decreased as the percentage of biodiesel increased for biodiesel blends of B_0, B_5, B_{10}, and B_{20}.
- The blend B_{20} outperformed all other types of blends in terms of braking power.
- The engine stalls at the lowest idle speed when using neat biodiesel. As a result, for maximum performance with neat biodiesel or higher biodiesel blend ratios, the rated idle speed must be set to fast idle.
- This research examined the performance and emission characteristics by varying blend ratio and engine speed with a fixed compression ratio. Therefore, we recommend other researchers to investigate the performance and emission characteristics by varying injection timing, compression ratio, and injection rate for optimum diesel engine operation.

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Data availability statement: Data will be available on request.

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