Comprehensive Review of Karanja & Jatropha Biodiesel Fuelled Diesel Engines

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The globe has been compelled to develop other fuels due to emission restrictions, the depletion of oil reserves, and rising prices of petroleum fuels. The rapid development of the automobile sector has resulted in an increase in demand for petroleum-based fuels. Petroleum-based fuels have a finite number of reserves. Biodiesel is a viable alternative fuel and has qualities that are similar to diesel fuel. By combining it with diesel, it can be a suitable fuel in diesel engines. Biodiesel, which is usually made from non-edible oils like jatropha and karanja, has sparked a lot of interest as a diesel engine alternative fuel. When compared to edible oil, non-edible oil are not used in human nutrition and could grow in barren lands. The goal of this study is to provide a review of the performance, combustion, and emission characteristics of jatropha and karanja biodiesel fuels as alternative fuels for diesel engines.

Keywords: Biodiesel, non-edible oil, karanja, jatropha, diesel engine.

1 Introduction

It is not a new concept to utilise biodiesel in diesel engines. Rudolph Diesel experimented with using vegetable oil as an alternative fuel [1]. However, because diesel was abundant and vegetable oil fuel was more costly than diesel, as a result, biodiesel research was not taken seriously. Biodiesel's key advantages are its portability and ready availability. It is non-toxic, biodegradable, and ecologically friendly, has a high flash point, and may be mixed with diesel due to similar properties. When vegetable oil is used as a fuel in a diesel engine, there are no serious issues. The transesterification procedure has proven to be one of the most effective ways to accomplish this. Various vegetable oils can be used to make biodiesel. Edible oil is in high demand as a food source. The use of non-edible oils will help to tackle the problem of fuel shortages while also reducing the demand for edible oils. Biodiesel is one of the most important alternative sources for diesel fuel, and it may be manufactured from a range of non-edible plants. [2] Engine trials and experiments have already been performed on a vast variety of nonedible and edible oils. Non-edible oils such as jatropha,karanj, neem, cottonseed, etc., on the other hand, are not acceptable for human consumption. Due to the presence of flavonoid constituents, karajin, the seed of karanja, includes pongam oil, which is bitter and non-edible with an unpleasant flavour. [6] Recent comprehensive analyses of biodiesel synthesis from diverse feedstocks demonstrate that non-edible oils have a number of advantages over edible oils. Biodiesel production from non-edible oil feedstocks can address the challenges of food vs. fuel, as well as environmental and economic concerns about edible vegetables [7]. They can also be planted along trains, roads, and irrigation canals, as well as on farmers' field boundaries, fallow fields, and public land. Various oils derived from non-edible crop seeds or kernels could be used as biodiesel feedstocks. jatropha [3], karanja [4], and other non-edible oil plants are essential. The oils of jatropha and karanja are the most commonly utilised feedstocks in biodiesel production.Edible oils are not produced in sufficient quantities in many countries to suit human needs, so they must be imported. As a result, biodiesel made from edible oils is substantially more expensive than petrodiesel. India is an intriguing case study in biodiesel generation from edible vegetable oils, where roughly 46% of the required amounts for domestic needs are imported [5]. Balat and Balat argued for non-edible vegetable oils such as jatropha, karanja, and mahua oils, which were briefly discussed in their summary of biodiesel processing development. [9]. Non-edible oilseed crops have numerous advantages including the fact that they require less water and can be grown on marginal or low fertility soil. [13] They can also be cultivated not only from seed but also from cuttings. They offer huge potential for creating rural jobs and lowering CO_2 emissions. The liquid form, portability, rapid availability, renewability, higher heat content, reduced sulphur content, lower aromatic content, and biodegradability are all advantages of non-edible oil. [10] Researchers are looking for new sources since there is a desire for renewable energy sources that are clean, dependable, and economically viable. Non-edible oils like jatropha and karanja are widely available and are simple to turn into biodiesel. A viable replacement for diesel fuel for diesel engines in this situation is biodiesel made from Jatropha and Karanja oil. The various results have been analysed and summarised while using Jatropha and Karanja oil and their mixes as the primary sources of fuel. The main objective of this work is to introduce its derivatives as efficient alternatives to traditional diesel fuels for CI engines.

2 Advantages of Karanja and Jatropha Plant

These trees occur in India, the United States, Sri Lanka, Indonesia, Australia, Pakistan, the Philippines, and Malaysia [33]. In India, karanja oil, which can be converted to biodiesel, is available abundantly. Karanja may be grown on every type of soil, including unproductive fields and degraded woods, irrigation channels, and road borders, and it is a simple plant to grow [15]. This plant only requires a small amount of water. Karanja is a medium-sized tree that looks like a neem tree and may be found all over India. Figure 1 depicts a karanja tree.

Figure 1: *Karanja (Pongamia pinnata) [30].*

With remarkable medical benefits and many uses, the karanja tree has gained a lot of attraction. Karanja wood is widely used as a fuel source and can also be used to make agricultural equipment. Many traditional medicines include the fruit and sprouts, as well as seeds. It is used in the medical field. The oil of the karanja or pongam is useful in agriculture and pharmacy. [14] The oil derived from the karanja seed has received a lot of attention as a diesel engine alternative fuel. The oil of karanja is a pale yellow liquid having antibacterial and medicinal properties. Because of its high phosphorous, nitrogen potash, potassium NPK content, it also performs well as a fertilizer. [20] Karanja is a 15–25 m tall, medium-sized evergreen, and a fast-growing medium-sized tree. Three to four years after planting, flowering begins and lasts for another four to seven years. Karanja oil contains a number of hazardous compounds that prevent it from being used as cooking oil.[8]

The jatropha is a small to medium-sized tree with a height of 3–5 metres. In some cases, the plants have a height of 8–10 metres. The bark of the tree is smooth and grey when it is chopped. When the stems are dry, they release a whitish-colored liquid latex that hardens and discolours [12]. The Indian government promotes jatropha biodiesel mostly because of its high oil content (66.4%) and ability to thrive in non-agricultural areas. The oil content of the seeds is 35–40%. Jatropha oil is commonly used to produce soap in India and other countries. Other than as a biodiesel feedstock, jatropha oil has a variety of uses, including soap manufacturing and biocides (molluscicides, insecticides, nematicides, and fungicides). Jatropha is a plant that has the ability to produce certain productive assets, the ability to boost village-based industries, and most importantly, the ability to develop wastelands. The methods for generating jatropha oil are straightforward, and the necessary apparatus is easily available. Figure 2 shows the jatropha plant.

Figure 2: *Karanja (Pongamia pinnata) [30].*

Jatropha curcas can be grown in both deserts and higher rainfall zones. In all forms of waste land, jatropha curcas can be an excellent plant material for eco-restoration. Plant cuttings of Jatropha curcas grow quickly. Jatropha curcas isn't thought to be a suitable forage plant. The plant is resistant to pests and diseases. Jatropha curcas helps to build soil carbon by collecting carbon from the atmosphere and storing it in its woody tissues.It is now the primary fuel for biodiesel manufacturing in poor nations such as India, where yearly production is around 15,000 t [5]. It can grow practically everywhere, on waste, sandy, and saline soils, in a variety of climatic situations, including low and heavy rainfall, as well as cold. Its cultivation is simple, requiring little attention and effort. Its 30 to 50 year healthy life cycle eliminates the need for yearly replanting. The oil content of jatropha varies depending on the species, although it is typically 40–60% in the seeds and 46–58% in the kernels [6]. Some living species, such as the tusser silk worm, feed on jatropha leaves. The leaves are high in protein, but they contain poisonous chemicals that prevent them from being used as cattle fodder. According to studies, the oil's toxic component is found in the alcohol-soluble portion. [11]

3 Properties of Karanja and Jatropha biodiesel

The most crucial fuel qualities taken into account while using non-edible biodiesels in diesel engines include density, viscosity, flash point, cetane number, cloud and pour point, and calorific value, among others. Numerous studies have revealed that non-edible biodiesels have favourable fuel characteristics. Consequently, it is required to measure the fuel quality of a few selected biodiesels before employing non-edible-based biodiesels in diesel engines. The fuel properties of karanja and jatropha non-edible biodiesels are shown in Table 1.

Table 1: Fuel properties of various non-edible biodiesel. [8]

Properties	**Karanja**	**Jatropha**
Density at40 ^{0}C (kg/m^3)	970-928	901-940
Viscosity at40 ^{0}C (mm^2/s)	27.8-56	24.5-52.76
Flash point (^{0}C)	198-263	180-280
Pour point (0C)	-3 to 6	-3 to 6
Cloud point (0C)	13-15	8-10
Cetane number	45-67	33.7-51
CalorificValue (MJ/kg)	34–38.8	38.20–42.15

4 Experimental Investigation on Karanja and Jatropha

Srivastava et al. [16] used a two-cylinder CI engine to test several karanja biodiesel mixes. They found that the thermal efficiency of karanja oil biodiesel is lower than that of diesel, but that the thermal efficiency of blending is higher than that of biodiesel. When comparing 100% biodiesel to a blend of 5%, 10%, 20%, and 30% biodiesel by volume, the thermal efficiencies are higher. They also found that HC, CO, and NOx emissions from the methyl ester of karanja oil were somewhat greater than those from ordinary diesel fuel. Almost all of the properties of the methyl ester of karanja oil are found to be very comparable to those of diesel oil with 5%, 10%, 15%, and 20% blends. The NOx emissions of biodiesel were higher than those of karanja biodiesel blends.Bajpai et al. [17] tested various diesel and karanja oil fuel blends(from 5% to 20%) at varying loads (from 0 to 100 %) to determine brake specific fuel consumption (BSFC), brake thermal efficiency (BTE), and exhaust emissions in a single-cylinder DI constant speed CI engine. It was discovered that a gasoline blend containing 10% karanja oil (K10) improved brake thermal efficiency at 60% load.

Baiju et al. [18] used methyl and ethyl esters of karanja oil to conduct a comparative study of CI engine characteristics. According to the results of the performance test, methyl esters have slightly higher power than ethyl esters. The exhaust emissions of both esters were almost the same. When compared to conventional diesel fuel, NOx emissions from pure biodiesel and diesel–biodiesel fuel blends increased by 10–25% at part loads. NOx emissions, on the other hand, decreased when the engine was fully loaded. Exhaust pollutants such as CO, HC, and smoke were reduced when neat biodiesel and mixes were used.P.K. Sahoo et al. [19] determined the proper blend for optimum performance, minimal emissions, and the best combustion characteristics. This is determined by the feedstock and subsequent biodiesel formulation. According to the findings, biodiesel made from unrefined jatropha, karanja, and polanga seed oils is a viable alternative to diesel.A.K.Agarwal et al. [20] Even without preheating, a single-cylinder diesel engine performed effectively during tests on karanja oil and its blends, requiring no changes to the engine components. Engine efficiency improved marginally when preheated gasoline was used. The engine's thermal efficiency is approximately 30% when using preheated oil blends and 24–27% while using unheated oil blends like K10, K20, and K50. With warmed lower mixes, the BSFC and brake specific energy consumption of the engine improved. Unheated and preheated lower blends (K10 and K20) have lower HC emissions than mineral diesel. As a result, karanja oil blends with diesel up to 50% (v/v) without or with preheating might be used to substitute diesel in CI engines, resulting in fewer emissions and better performance.

By combining karanja oil with Petro-Diesel and preheating the karanja-Diesel blend, Kamal Kishore Khatri et al. [21] have created an experimental setup to minimise the viscosity of the fuel. On a constant speed direct injection C.I. engine, experiments are conducted utilising a Petro-Diesel and a warmed karanja-Diesel blend (in a ratio of 40:60 by volume). On the warmed karanj-Diesel blend, the influence of injection timing is examined. On the basis of the findings, the best injection timing for the karanj-Diesel blend is determined to be 19° BTDC. It has been discovered that a 40 percent substitution of diesel oil by karanj oil works best in the temperature range of 55-60°C, as the viscosity of the blend equals that of pure diesel. As a result, it is possible to conclude that preheating and blending vegetable oils with diesel can significantly lessen the issues associated with straight vegetable oils, making them a viable option for diesel fuel.P. V. Rao [22] investigated the impact of karanja methyl ester characteristics on diesel engine combustion and nitrogen oxide emissions. The study takes into account the various properties like viscosity, density, calorific value, iodine value, cetane number, and oxygen % of the karanja methyl ester. The engine trials were conducted with karanja methyl ester (with and without preheating) and baseline diesel. Methyl ester had somewhat higher peak pressures and peak heat release rates than diesel fuel. The nitrogen oxides of karanja methyl ester increased by 6% at maximum load, according to the findings. The use of warmed methyl ester results in a considerable reduction in nitrogen oxide emissions..

Atul Dhar et al.[23] conducted trials on direct injection CI engines at various engine loads and constant engine speed with various karanja oil blends (K10, K20, K50, and K100) with mineral diesel in unheated conditions. When compared to mineral diesel, all karanja oil blends have lower fuel consumption and thermal efficiency. The amount of HC emitted was reduced. When compared to diesel, NOx emissions were greater and smoke opacity was lower for all mixes. They recommended using a 20% blend with diesel in a diesel engine.Naveen Kumar et al. [24] compare the performance, emissions, and combustion properties of biodiesel made from non-edible karanja oil. One of the performance characteristics assessed in this study is the brake thermal efficiency of karanja biodiesel with varied compositions at 5%, 10% , 20%, 30%, and 100% with mineraloil. Diesel is one of the performance characteristics assessed in this study. In comparison to diesel, BTE was roughly 3% to 5% lower with karanja biodiesel and its blends. With karanja biodiesel fuel, the amount of unburned hydrocarbons, CO, CO_2, and smoke was reduced. The NOx emissions of karanja biodiesel and its blends, on the other hand, were higher than those of diesel.

A.K. Agarwal et al. [25] tested 10%, 20%, and 50% blends of karanja oil (viscosity-35.98 cSt) with diesel to compare the performance to baseline mineral diesel. It is observed that all karanja oil blends have lower fuel consumption and thermal efficiency. HC emissions were lower for karanja oil blends than mineral diesel. Higher karanja oil mixes resulted in slightly higher CO and NOx emissions. They concluded that a 20 % karanja oil/diesel combination produces satisfactory engine performance.Ting Zhao and Mohammed Takase [26] have focused on the use of non-edible resources. Evergreen multipurpose non-edible plants such as neem, karanja, rubber, and jatropha are widely available and may be grown in a variety of socioeconomic and environmental situations. As a result, this research was conducted to investigate the multipurpose nature of these four non-edible tree species. According to the findings, these four multipurpose non-edible tree species (neem, karanja, rubber, and jatropha) have significant potential as non-edible biodiesel feedstocks for ensuring long-term bioenergy production.L. Karikalan et al.[27] conducted experimental analysis on the CI engine to evaluate the performance and emissions with various compositions of karanja biodiesel and their blends at 5% to 100% with mineral diesel. The HC, CO, CO_2, and smoke levels were reduced when using karanja biodiesel gasoline, but the NOx level increased compared to diesel. The results show that an engine running on karanja biodiesel and its blends with diesel fuel performs similarly to a pure diesel engine.

Rupesh L. Patela et al.[28] studied Transesterification, pyrolysis, micro emulsion, and blending are the four major methods for manufacturing biodiesel that have been researched. The best blend for a diesel engine (B20) is a 20% mixture of karanja oil methyl ester and diesel. The BTE and BSFC of B20 are comparable to those of diesel. When more karanja oil methyl ester is mixed with diesel, CO, HC, and smoke emissions are reduced while NOx emissions are increased.A.M. Ashraful et al. [30] analysed the numerous experimental findings and concluded that CO and HC emissions rise with EGR operation due to the high engine load, but then fall due to the high percentage of biodiesel in fuel blends. CO emissions are reduced by 5.5-35.2% and HC emissions are reduced by 14.91-32.28% as a result of the high biodiesel percentage in gasoline blends. NOx emissions rise with increased engine load and biodiesel content in fuel blends, which fall with EGR operation but rise with increased engine load and biodiesel content in fuel blends. In some cases, NOx emissions can increase by 3.29-10.75%. However, in a full load condition, it lowers.

K. Acharya et al. [31] the performance and emission characteristics of a compression ignition engine fueled with warmed karanja oil and its blends (10% and 20%) with diesel were investigated. The viscosity of unheated 10%, 20% mix, and preheated oil has been demonstrated to be appropriate for diesel engines. The performance of blended karanja oil under the above settings, according to the results of the experimental investigation, is comparable to that of diesel in a diesel engine with no operating concerns. It was also determined that, when compared to diesel and the aforementioned mixes, preheated karanja oil at 120°C can be used in a diesel engine with somewhat inferior performance and emissions.Md. Nurun Nabi et al.[32] discuss the work production of KME in Bangladesh and the characterization of KME (B100) and its blends. B100 and similar blends emit less CO, smoke, and engine noise, but they emit more NOx. When compared to diesel fuel, the B100 reduced CO and smoke emissions by 50% and 43%, respectively, while increasing NOx emissions by 15% using the same fuel. KME reduced CO, smoke, and engine noise while increasing NOx emissions due to the presence of oxygen in its molecular structure.

Y.C. Sharma et.al. [33] studied the production of biodiesel from the karanja tree, which is primarily found in rural India. The biodiesel was created using oil extracted from the tree's seeds. The oil's molecular weight was calculated and found to be 892.7. After that, both acid and alkaline esterification were used to create the final product.L.M. Das et al.[35] carried out studies on non-edible methyl esters generated from jatropha karanja and polanga oil, which were developed and blended with regular diesel containing less than 10 mg/kg sulphur. They used a water-cooled three-cylinder tractor engine with various different fuel blends (diesel, B20, B50, and B100). It is found that a 50% jatropha biodiesel and diesel combination produces the most power boost at rated speed. For all biodiesel mixes, brake specific fuel consumption increases with speed. L.M. Das and P.K. Sahoo [36] Biodiesel made from oil crops has the potential to be a renewable and carbon-neutral substitute for petroleum fuels. Biodiesel is a chemical compound made up of monoalkyl esters of long-chain fatty acids generated from renewable feedstocks such as vegetable oils and animal fats. The viscosity and freezing point of biodiesel increase with the length of the carbon chain and decrease with the length of the double bond chain.

K. Pramanik [37] studied jatropha curcas oil and efforts were made to reduce the viscosity in order to make it suitable for use in a CI engine. The viscosity of vegetable oil was significantly reduced when it was diluted with diesel in various amounts. The viscosity of the blended products, including 70% and 60% vegetable oil, got close to that of diesel at temperatures of 70–75°C and 60–65°C. Acceptable braking thermal efficiency and SFCs were achieved with blends containing up to 50% jatropha oil. Following the engine tests, it was discovered that up to 50% jatropha curcas oil can be used as a diesel alternative in a CI engine without producing severe complications.Deepak Agarwal et al. [38] conducted an experiment on the measuring of jatropha oil viscosity at different temperatures in the range of 40–100°C to evaluate the performance of the CI engine with preheated jatropha oil. The use of waste heat from exhaust fumes to warm jatropha oil (JO) is sufficient to reduce viscosity to levels comparable to diesel fuel.When compared to clean jatropha oil, warmed JO had lower BSFC and exhaust gas temperatures. Heated jatropha oil has a better thermal efficiency than raw jatropha oil. Preheated jatropha oil had CO_2, CO, HC, and smoke opacity that were comparable to diesel fuel. They came to the conclusion that heating jatropha oil in CI engines can be employed in rural regions for agricultural and irrigation purposes.

Jindal et al. [39] performed the trial with three values of injection pressure and compression ratio. The engine's best performance is achieved at 250 bar injection pressure and a compression ratio of 18, where BSFC improves by 10% and BTE improves by 8.9%.The emissions of HC, NOx, smoke opacity, and exhaust temperature are lower with pure bio-diesel than with diesel fuel for all combinations of compression ratio and injection pressure.Hao Chen et al. [40] studied the combustion process and temperature, biodiesel properties, and engine operation circumstances that have a large impact on NOx emissions. The NOx emissions of biodiesel are lower than those of diesel for low loads and low and medium engine speeds. At medium and high loads, the BTE of the B100 is higher than that of the D100, and the difference grows with engine load. Between B100 and D100, the rise in NOx emissions increases with engine load. The main influencing factors are engine loads, engine speeds, and biodiesel characteristics. The impact of these parameters on NOx emissions is not isolated, but rather complex and interacting.

Determine the acceptability of jatropha curcas oil (unheated and warmed) as an extended fuel for CI engines, as well as the engine's performance and emission characteristics, are the main objectives of this study by Bhupendra Singh Chauhan et al. [41]. In a performance and emission study of preheated jatropha oil on CI engines, the ideal fuel input temperature was found to be 80°C when considering BTE, and gaseous emissions in a performance and emission study of preheated jatropha oil on CI engines. As the percentage of biodiesel in the diesel–biodiesel blend increases, HC emissions drop. When compared to diesel fuel, increasing the percentage of biodiesel reduces HC emissions by 14.91-27.53%. HC emissions were found to be lower at full load. As the amount of biodiesel in the blend increases, CO emissions decrease by 6.51-12.32%. CO emissions are reduced as compared to diesel fuel. CO emissions are reduced by 10–40% when the system is fully loaded. The increase in CO emissions is noted as the load percentage increases. NOx emissions can rise by 3.29-10.75% in some cases. However, at maximum load, it drops by 5–10%. The opacity of the smoke decreases as the percentage of biodiesel in the blend increases, but increases as the load increases. [27,43].F.K. Forson et al. [42] examine the performance of jatropha oil and its blends with diesel in a single-cylinder DI diesel engine. It was observed that pure jatropha, pure diesel, and mixes of jatropha and diesel oil all operated similarly and had broadly similar emission levels under identical operating conditions. The most important conclusion is that a 97.4% diesel/2.6% jatropha fuel blend produces the greatest brake power and thermal efficiency, as well as the least specific fuel consumption.

Paul et al. [44] studied the numerical and experimental performance of JOME fuelled with a twin-cylinder diesel engine and found that the thermo-physical properties of JOME, such as density, cetane number, flash point, and fire point, are higher than those of diesel fuel. The brake thermal efficiency of jatropha biodiesel is less than diesel fuel. The particulate matter and smoke emissions were all lowered, but there was an increase in NOx emissions [40]. The acceptability and long-term viability of jatropha biodiesel in diesel engines were investigated by Kuber Singh Mehra et al. [45]. BTE increases when braking power increases for the complete combination of fuels. The maximum thermal efficiency of pure diesel (B0) is 29.8%, while the maximum thermal efficiency of pure biodiesel (B100) is 19.2%. As the percentage of biodiesel in blends grows, NOx emissions rise. Biodiesel with a 10% blend (B10) produces a product that is remarkably similar to pure diesel. While hydrocarbon emissions have decreased, NOx emissions have risen as the percentage of biodiesel in various blend compositions has grown. A mixture of 10-20% jatropha biodiesel and mineral diesel (B10 and B20) has been discovered to be suitable for use as a fuel in CI engines. The benefits of employing non-edible oils in biodiesel production are demonstrated by Ivana B. Bankovic-Ili et al. [46]. Under low loads and low and medium engine speeds, biodiesel produces a slight reduction in NOx emissions when compared to diesel. On the basis of biodiesel combustion characteristics, a full experimental investigation of NOx emission was carried out. At low loads and medium speeds, the negative effects of high viscosity and distillation temperature on the spray quality and homogeneity of the air fuel mixture are obvious. Biodiesel emits less NOx than diesel because it has a lower BTE and combustion temperature..

Anu Kumar Das et al. [47] offer a comparative analysis of jatropha curcas-based insulating oil based on experimental results from previous investigations, as well as the current state and future development needs. Jatropha curcas oil is non-edible, so it won't add to the food scarcity, and the jatropha plant is less susceptible to weather extremes. In terms of thermal capability, the results of this study reveal that jatropha curcas oils have high thermal stability. However, the long-term performance of the jatropha Curcas oil must be investigated in order to learn more about its material compatibility, partial discharge behaviour, stray gassing tendencies, and ageing performance.According to Dhandapani Kannan et al. [48]

a 20% biodiesel blend has a 0.09-2.64% higher engine power than diesel fuel. Engine output decreases as the percentage of biodiesel in the fuel blend rises. At medium engine speeds, BTE improves minimally, whereas at high engine speeds, BTE improves by 0.1–6.7%.

Diesel engines can operate with minimal to no changes when using biodiesel made from vegetable and animal fats. Compared to diesel fuel, biodiesel emits less CO, HC, and PM but more NOx. Although biodiesel creates more CO_2 than other fuels, it is regarded as carbon-neutral to offset the CO_2. According to research, because they are less compressible, more viscous, and have a higher cetane number than diesel fuel, most biodiesel fuels (with the exception of eucalyptus and pine oil) and their mixes with diesel have an earlier start of combustion and a shorter ignition delay. P. Tamilselvana et al. [49]. It is also concluded that diesel engines can operate with minimal to no modifications using biodiesel blends up to 20%.M.Suresh et al. [50] examined the performance and emission studies of biodiesel on VCR. Without requiring any modifications, biodiesel may replace diesel in the VCR engine. By switching to a VCR engine, you can get improved performance, lower emissions of dangerous gases including HC, CO, CO_2, and NOx, and faster combustion. It was amply demonstrated that VCR engines have the ability to boost combustion efficiency, decrease ignition latency, and deliver higher compression ratios under a variety of loads. According to the reviews listed above, it was discovered that the VCR engine has greater management at peak cylinder pressure, which lowers fuel consumption. Other benefits of using biodiesel in the VCR engine include a decrease in power usage and noise levels, among others.

5 Conclusion

This paper provides a detailed overview of the substantial contributions made by researchers working on biodiesel derived from non-edible oil, particularly karanja and jatropha, and its blend with diesel.Several investigations were conducted to measure the power output, BSFC, and BTE of an engine running on non-edible oil-based biodiesel. With brake thermal efficiency and brake specific fuel consumption approximately comparable to diesel, the performance of an engine running on a blend fuel (20% biodiesel and 80% diesel) was found to be superior to that of other blend fuels. The most optimal Karanja/diesel blend, B20, has BTE and BSFC levels that are practically identical to diesel. According to the findings of multiple experiments, using karanja biodiesel in CI engines can decrease CO, HC, and smoke emissions while increasing NOx emissions. With enhanced blending, CO, HC, and smoke emissions are decreased while NOx emissions are raised. Jatropha biodiesels showed higher BSFC but better thermal efficiency than other biodiesels in most circumstances. The thermal efficiency of jatropha oil blends was also shown to be comparable to diesel. In comparison to petroleum diesel, it has been discovered that jatropha biodiesel and its mixes with diesel fuel generally cause an increase in NOx emissions and a decrease in HC, CO, and PM emissions. Jatropha biodiesel performs satisfactorily when utilised in C.I. engines. When diesel fuel is blended with 20% jatropha biodiesel, a comparable improvement in fuel efficiency is seen. Numerous studies using jatropha biodiesel reveal variations in brake thermal efficiency (BTE) and brake specific fuel consumption (BSFC). In some circumstances, mixed biodiesel offers superior brake power (BP) to regular diesel fuel. Some research found that Jatropha biodiesel use was associated with a reduction in BTE. Engine power falls as the percentage of biodiesel in the fuel blend rises. BTE marginally improves for blends of B20. But as the percentage of jatropha biodiesel in the fuel blend rises, BTE falls. The majority of studies have found significant NOx emissions. Meanwhile, several authors have verified that using biodiesel results in fewer NOx emissions. The results are better with heated jatropha and karanja oil. More research is needed on long-term storage of karanja oil-diesel blends, NOx emissions reduction, and engine wear. Diesel engines may operate with minimal to no modification when using biodiesel blends up to 20%. According to the literature, the majority of engine tests are performed on single-cylinder diesel engines, with very few on multicylinder engines. In addition to engine performance and emission characteristics, the properties of non-edible biodiesel demonstrate that there is a high possibility of manufacturing biodiesel from non-edible sources in the future. Non-edible biodiesel has good potential as an alternate fuel for diesel engines in the near future.

Abbreviations

BSFC: Brake specific fuel consumption
BTE: Brake Thermal Efficiency
BP:Brake Power
DI:Direct injection
CI: Compression ignition
K10:10 % karanja oil
B10: Biodiesel with a 10% blend
B100: Pure biodiesel
D100:Pure diesel
BTDC: Before top dead center
CO: Carbon monoxide
HC: Unburned hydrocarbons
NOx: Oxides of nitrogen
JOME: Jatropha methyal ester
JO: Jatropha oil
KME: Karanja methyl ester
VCR :Variable compression ratio

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