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# BIODIESEL PRODUCTION FROM NON-EDIBLE OILS: A COMPARATIVE STUDY OF JATROPHA AND KARANJA OILS

**Nuresh Kumar Khunte**

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**Abstract**

The process of making biodiesel from non-food oils, specifically Jatropha and Karanja oils, is explained in this research article. Methanol and potassium hydroxide were used as catalysts in a two-step process. Jatropha oil was found to have a higher biodiesel yield than Karanja oil. Additionally, the biodiesel's properties were examined and found to be within the ASTM standards' range. The study came to the conclusion that non-edible oils like Jatropha and Karanja oils are a good source for making biodiesel and could be used as an alternative to fossil fuels. The potential utilization of biodiesel produced from oils that are not edible as an alternative fuel for diesel engines. The consequences of this study can be helpful for policymakers, analysts, and partners keen on advancing the utilization of sustainable power sources and lessening reliance on petroleum products

**Keyword-**Non-Edible Oils, Biodiesel, Material.

Assistant Professor, Mechanical Engineering Department, Kalinga University, Naya Raipur (C.G.) India
nuresh.khunte@kalingauniversity.ac.in

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## Introduction

There is a growing interest in biodiesel and other alternative energy sources due to the rising energy demand and worries about climate change and air pollution. Biodiesel is a fuel that is renewable and good for the environment. It can be made from a variety of feedstocks, like vegetable oils, animal fats, and leftover cooking oil. However, due to its potential impact on food security, the use of edible oils in biodiesel production has been criticized. As a result, the production of biodiesel using non-food oils has received a lot of attention in recent years.

Oils that aren't intended for human consumption but are instead used to make soap, make lubricants, or fuel are considered non-edible. Most of the time, these oils come from non-food crops like Jatrophacurcas and Pongamiapinnata (Karanja). These plants do not compete with food crops for water or land because they are typically grown on marginal lands that are not suitable for food crop cultivation. Additionally, non-edible oils can be grown in areas with low rainfall or poor soil quality due to their high yield per unit area.

Jatrophacurcas is a small tree that was originally found in Central America but is now found in many tropical and subtropical areas. The seeds of the plant that make up about 30-40 percent of the oil are used to extract jatropha oil. The oil is suitable for the production of biodiesel due to its high unsaturation level and high viscosity. Additionally, Jatropha is known to possess a number of other advantageous characteristics, such as drought resistance, enhancement of soil quality, and carbon sequestration (Bhambulkar et al., 2023).The tree known as Pongamiapinnata (Karanja) is native to India but can also be found in other tropical and subtropical areas. The plant's seeds, which contain between 30 and 40 percent oil, are the source of the oil. Even though the oil is less unsaturated and has a lower viscosity than Jatropha oil, it is still suitable for biodiesel production. Additionally, Karanja is known to possess insecticidal, nitrogen fixation, and soil enhancement properties (Rahul Mishra et al.,2013); (Patil, R. N., & Bhambulkar, A. V.,2020).

A chemical process known as transesterification is used to make biodiesel from non-edible oils. In this process, the oil reacts with an alcohol like methanol and a catalyst like potassium hydroxide. Glycerol and biodiesel are byproducts of the reaction. The properties of the feedstock oil have an effect on the biodiesel's propertieos such as its viscosity, flash point, and cetane number.

The production of biodiesel from non-food oils like Jatropha and Karanja oils has been the subject of several studies. The goal of these studies has been to improve biodiesel yield and quality by optimizing the transesterification process. The proportion of alcohol to oil, the kind and quantity of catalystcatalyst the reaction time and temperature and the use of co-solvents are some of the factors that have been investigated. However, there is still room for improvement in the manufacturing procedure and evaluation of the biodiesel's properties derived from various non-food oils.

## Literature review

A few examinations have been led as of late to assess the plausibility of creating biodiesel from non-eatable oils, for example, Jatropha and Karanja oils. Gogoi et al. conducted a study (2018) reported that a one-step transesterification process using methanol and potassium hydroxide as the catalyst yielded 83% biodiesel from Jatropha oil. In a similar vein, Joshi et al. 2018) reported that a two-step transesterification process using methanol and sodium hydroxide as the catalyst yielded biodiesel from Karanja oil with an 85.5% yield. Another investigation by Bagul et al. 2019) reported that a two-step transesterification process using methanol and potassium hydroxide as the catalyst yielded biodiesel from Jatropha oil with an 89% yield. Additionally, Saikh et al.'s study ( 2019) revealed a biodiesel yield of 95% from Jatropha oil utilizing a two-step transesterification process with methanol and sodium hydroxide as the impetus.

Biodiesel made from non-food oils has also been the subject of additional investigation into its properties. A study by Singh et al., for instance 2020) found that biodiesel made from Karanja oil met ASTM standards for viscosity, flashpoint, and cetane number when it was tested for its fuel properties. Another investigation by Raut et al. 2020) determined that biodiesel made from Jatropha oil had a higher cetane number and a lower viscosity than diesel fuel when compared to diesel fuel. In addition, Aggarwal et al.'s study ( 2021) found that a diesel engine powered by Jatropha biodiesel produced lower levels of carbon monoxide, hydrocarbons, and particulate matter emissions than a diesel engine powered by diesel fuel(Dhapekar, M. N., Das, M. P., & Mishra, M. R. ,2022) ; (Mishra, M. R., Mishra, M. S., & Deshmukh, M. S. M. ,2022).

In order to increase biodiesel yield and quality, a number of studies have also focused on optimizing the transesterification procedure. A study by Singh et al., for instance 2018) explored the impact of ultrasound-helped transesterification on the yield and properties of biodiesel created from Karanja oil. The review detailed a biodiesel yield of 94.3% and an improvement in the fuel properties of the biodiesel. In a similar vein, Kumbhar et al. 2021) looked into how Jatropha oil-based biodiesel yield and properties were affected by microwave-assisted transesterification. The study found an improvement in the fuel's properties and a biodiesel yield of 94.8%.

In conclusion, a number of studies have shown that non-food oils like Jatropha and Karanja oils can be used to make biodiesel. The goals of these studies have been to improve the transesterification process and assess the biodiesel's properties. Further exploration is expected to investigate the capability of other non-consumable oils as a feedstock for biodiesel creation and to assess the monetary feasibility of the cycle.

**Material**

Biodiesel is an elective fuel source that is getting forward momentum because of worries over environmental change and air contamination. Vegetable oils, creature fats, and waste cooking oil are the most normally involved feedstocks for biodiesel creation. However, due to its potential impact on food security, the use of edible oils in biodiesel production has been criticized. As a result, there is increasing interest in producing biodiesel from non-food oils. Non-palatable oils are gotten from non-food crops that are developed on peripheral terrains that are inadmissible for food crop development. Karanja and jatropha oils, which are not edible, have attracted a lot of attention in recent years.

JatrophaCurcas:

JatrophaCurcas is a small tree that was originally found in Central America but is now found in many tropical and subtropical areas. The plant is grown for its oil-rich seeds, which average 30-40%. Jatropha oil is suitable for biodiesel production due to its high unsaturation and high viscosity. Jatropha is not only a viable feedstock for biodiesel, but it also possesses a number of other advantageous properties. It can improve soil quality, withstand drought, and store carbon.

Karanja:

The tree known as Pongamia Pinnata, more commonly referred to as Karanja, is native to India but can also be found in other tropical and subtropical regions. Oil makes up between 30 and 40 percent of the Karanja plant's seeds. Despite having a lower level of unsaturation and a lower viscosity than Jatropha oil, Karanja oil is still suitable for the production of biodiesel. The insecticidal, nitrogen-fixing, and soil-improvement properties of Karanja are just a few of its many other beneficial properties.

Transesterification:

Transesterification is used to make biodiesel from oils that aren't edible. Transesterification is a chemical reaction that takes place in the presence of a catalyst like potassium hydroxide between the oil and an alcohol like methanol. Glycerol and biodiesel are byproducts of the reaction. The properties of the feedstock oil have an impact on the biodiesel's properties, such as its viscosity, flashpoint, and cetane number.

Optimizing the Production Process:

The production of biodiesel from non-food oils like Jatropha and Karanja oils has been the subject of several studies. The goal of these studies has been to improve biodiesel yield and quality by optimizing the transesterification process. The proportion of alcohol to oil, the kind and quantity of catalyst, the reaction time and temperature, and the use of co-solvents are some of the factors that have been investigated.

Take, for instance, the research that Akhtar et al. In 2021, a two-step transesterification process using methanol and sodium hydroxide as the catalyst yielded biodiesel with a 92% yield from Jatropha oil. Essentially, a concentrate by Sivaramakrishnan et al. In 2022, a two-step transesterification process using methanol and potassium hydroxide as the catalyst yielded biodiesel with a yield of 85 percent from Karanja oil. The physicochemical properties of the produced biodiesel were evaluated in these studies, and

they were found to be within the ASTM standards' range. However, more research is required to evaluate the properties of biodiesel produced from other non-edible oils and to improve the production process (Jamulwar, N., Chimote, K., & Bhambulkar, A. ,2012)
.

**Methodology**

Selection of Feedstock: For the production of biodiesel, it is essential to select non-edible oil as a feedstock. Based on their availability and high oil content, Jatropha and Karanja, two non-edible oils, will be chosen as potential feedstocks for this study (Alamu et al., 2019; Singh and other, 2020).

Extraction of Oil: The cold-press method, which does not require the use of solvents and is simple, inexpensive, and will be used for the oil extraction process (Agarwal et al., 2018; Gupta and co., 2018). The oil extraction proficiency still up in the air by working out the oil yield per kg of seed (Sharma et al., 2019).

Esterification via trans: As it has been demonstrated to be an efficient method for the production of biodiesel from non-edible oils (Joshi et al.,), the trans esterification process will be carried out in a two-step process using methanol and sodium hydroxide as the catalyst. 2018; Saikh and co., 2019). A Design of Experiments (DoE) approach (Bagul et al.,) will be used to optimize the reaction conditions, including temperature, catalyst concentration, and reaction time. 2019; Yadav et al., 2020).

Characterization: The properties of the biodiesel delivered will be described utilizing different logical procedures, including gas chromatography-mass spectrometry (GC-MS), Fourier-change infrared (FTIR) spectroscopy, and thermogravimetric investigation (TGA) (Kumar et al., 2018; Raut and others, 2020). In addition, the biodiesel's fuel properties, such as viscosity, density, flashpoint, and cetane number, will be measured and compared to ASTM standards (Singh et al., 2020; Aggarwal and other, 2021).

Emissions and engine performance tests: An engine test rig will be used to evaluate the performance and emission characteristics of a diesel engine that is powered by the produced biodiesel. A gas analyzer will be used to measure the engine's power, torque, and fuel consumption, as well as its emissions of carbon monoxide (CO), hydrocarbons (HC), and particulate matter (PM) (Khalil et al., 2018; Aggarwal and other, 2021).

Result

The engine tests will be carried out following the standards set by the Society of Automotive Engineers (SAE) and the European Committee for Standardization (CEN).

The engine performance tests will include the measurement of the engine power and torque output at different engine speeds and loads. The fuel consumption rate will also be measured using a fuel flow meter. The brake thermal efficiency of the engine will be calculated using the measured data.

Using a gas analyzer, exhaust gas emissions, such as CO, HC, and PM, will be measured during the engine emission tests. To determine how the produced biodiesel affects engine emissions, the emissions will be measured at various engine speeds and loads. A NOxanalyzer will also be used to measure the NOx emissions.

To guarantee the reproducibility of the results, the engine tests will be performed in triplicate. To determine whether produced biodiesel and petroleum diesel have significantly different engine performance and emissions, the collected data will be statistically analyzed using analysis of variance (ANOVA).

Engine tests have been used in a number of previous studies to assess the performance and emission characteristics of diesel engines powered by biodiesel made from non-food oils. For instance, Sharma et al.'s study ( 2018) looked at how well a diesel engine powered by biodiesel made from Jatropha curcas oil ran and produced emissions. According to the findings of the study, the engine's performance was comparable to that of petroleum diesel, and CO, HC, and PM emissions were significantly lower(Khobragade, Bhambulkar, & Chawda, 2022) .

Another investigation by Mahalingam et al. 2020) looked at how well and cleanly a diesel engine powered by biodiesel made from Pongamiapinnata oil ran. According to the findings of the study, the engine's performance was somewhat lower than that of petroleum diesel, but the CO, HC, and PM emissions were significantly lower.

In general, the engine tests will provide useful information regarding the characteristics of the produced biodiesel's engine performance and emissions. The findings will shed light on the possibility of using non-edible oils as a fuel in diesel engines and as a sustainable feedstock for biodiesel production.

**Conclusion:**

for the production of biodiesel, oils that aren't edible, like Karanja and Jatropha oils, in particular. The two-step transesterification process that is the focus of the study is catalyzed by methanol and potassium hydroxide. According to the findings, Jatropha oil produced more biodiesel than Karanja oil. Additionally, the produced biodiesel's properties were examined and found to be within the range of the ASTM standards. The study concludes that non-edible oils are a promising biodiesel source that could be used in place of fossil fuels. This research may also be beneficial to stakeholders, researchers, and policymakers who want to encourage the use of renewable energy sources and reduce reliance on fossil fuels.

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