

Production and Characterization of Biodiesel from Non-Edible Oil by Transesterification

Sanjay Mohanty¹, Sasmita Sahoo²

ABSTRACT

Biodiesel, a renewable and biodegradable fuel produced from vegetable oils and fats, offers an alternative to petroleum diesel, and using non-edible oils as the feedstock avoids competition with food supply. This paper reports the production and characterization of biodiesel from a non-edible oil by transesterification. The oil was converted to biodiesel by base-catalysed transesterification with methanol, the effect of the catalyst concentration on the yield was studied to identify the optimum, and the fuel properties of the biodiesel produced were measured and compared with standard specifications. The results show that the transesterification produced a high yield of biodiesel, that the yield increased with catalyst concentration up to an optimum beyond which it declined owing to soap formation, and that the fuel properties of the biodiesel, including density, viscosity, flash point, acid value, and cetane number, met the standard specifications. The study demonstrates that the non-edible oil is a suitable feedstock for producing biodiesel of acceptable quality by transesterification.

KEYWORDS: *Biodiesel, Transesterification, Non-Edible Oil, Fuel Properties, Renewable Energy, Catalyst, Fatty Acid Methyl Esters*

INTRODUCTION

The depletion of petroleum reserves and the environmental impact of fossil fuels have driven the search for renewable alternatives, among which biodiesel is prominent. Produced from vegetable oils and animal fats, biodiesel is renewable, biodegradable, and burns more cleanly than petroleum diesel, and it can be used in existing diesel engines (1, 7).

Using edible oils for biodiesel, however, raises concerns about competition with food supply and cost, which has directed attention to non-edible oils as feedstocks (6, 9). Biodiesel is

produced from such oils mainly by transesterification, in which the oil reacts with an alcohol in the presence of a catalyst to form fatty acid esters and glycerol (2, 3).

This paper reports the production of biodiesel from a non-edible oil by base-catalysed transesterification with methanol. The effect of catalyst concentration on the yield is studied, and the fuel properties of the biodiesel are measured and compared with standard specifications (4, 5).

LITERATURE REVIEW

The production of biodiesel by transesterification has been reviewed comprehensively, covering feedstocks, catalysts, and process variables (1, 2, 5). Base-catalysed transesterification with methanol is the most common route, being rapid and giving high yields with refined oils of low free-fatty-acid content (3).

The variables affecting the yield, including the alcohol-to-oil ratio, catalyst type and concentration, temperature, and reaction time, have been studied in detail (3, 5). The properties of biodiesel depend on the fatty-acid composition of the feedstock and must meet established standards for use as a fuel, as documented in reviews of biodiesel characterisation and non-edible feedstocks (4, 6, 8, 9).

Variables in Transesterification

The literature identifies several variables that govern the transesterification reaction and biodiesel quality (2, 3, 5). The principal ones considered here can be summarised as follows:

- The alcohol-to-oil molar ratio used in the reaction.
- The catalyst type and concentration.
- The reaction temperature and time.
- The yield of fatty acid esters obtained.
- The fuel properties of the biodiesel relative to standards.

RESEARCH GAP

Although biodiesel production by transesterification is well established, concise studies that produce biodiesel from a non-edible oil, identify the optimum catalyst concentration, and report the fuel properties against standards together remain useful as practical demonstrations.

This study addresses that need by producing biodiesel from a non-edible oil and evaluating the yield and fuel properties.

OBJECTIVES

- To produce biodiesel from a non-edible oil by base-catalysed transesterification.
- To study the effect of catalyst concentration on the biodiesel yield.
- To identify the optimum catalyst concentration.
- To measure the fuel properties of the biodiesel produced.
- To compare the fuel properties with standard specifications.

METHODOLOGY

Biodiesel was produced from a non-edible oil by transesterification with methanol using a base catalyst. The catalyst concentration was varied to determine its effect on the yield, and the biodiesel produced under the optimum conditions was separated, purified, and characterised for its fuel properties (2, 3).

Transesterification Procedure

The non-edible oil was reacted with methanol in the presence of a base catalyst at a controlled temperature with stirring. After reaction, the mixture was allowed to settle, the glycerol layer was separated, and the biodiesel was washed and dried. The reaction conditions are summarised below (3, 5).

Table 1: Transesterification Reaction Conditions

Parameter	Value
Feedstock	Non-edible vegetable oil
Alcohol	Methanol
Catalyst	Base catalyst (potassium hydroxide)
Methanol-to-oil molar ratio	6:1
Catalyst concentration	0.5 to 2.0 wt%
Reaction temperature	60 C

Yield and Fuel-Property Evaluation

The yield of biodiesel was determined at each catalyst concentration to identify the optimum, and the biodiesel produced under the optimum conditions was characterised by measuring its density, kinematic viscosity, flash point, acid value, and cetane number, which were compared with standard specifications (4, 8).

RESULTS AND FINDINGS

The biodiesel yield as a function of catalyst concentration is shown in Figure 1. The yield rose with catalyst concentration to a maximum at an intermediate value and then declined, the optimum giving a high yield, with the decline at higher concentrations attributable to soap formation (3, 5).

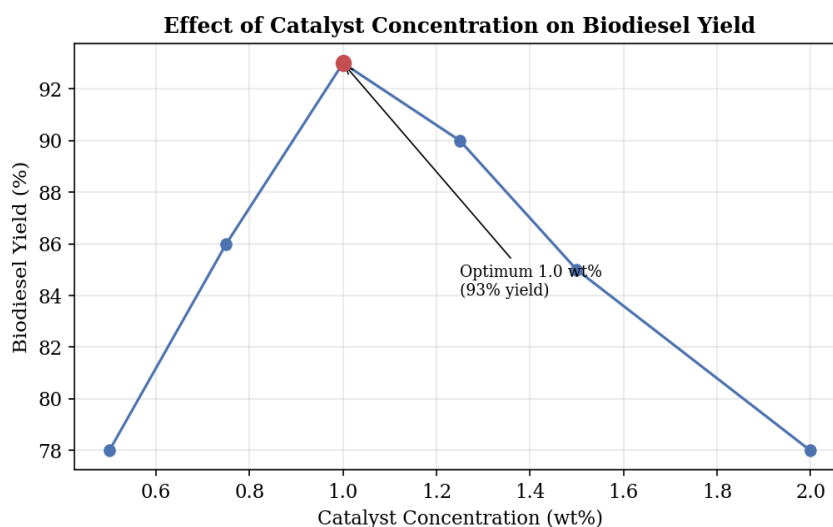


Figure 1: Effect of Catalyst Concentration on Biodiesel Yield

Table 2 reports the fuel properties of the biodiesel produced under the optimum conditions, compared with standard specifications. The density, viscosity, flash point, acid value, and cetane number all fell within the specified limits.

Table 2: Fuel Properties of the Biodiesel Compared with Standards

Property	Biodiesel	Standard Specification
Density at 15 C (kg/m ³)	878	860-900
Kinematic viscosity at 40 C	4.6	1.9-6.0

(mm ² /s)		
Flash point (C)	165	Greater than 130
Acid value (mg KOH/g)	0.32	Less than 0.50
Cetane number	54	Greater than 47
Biodiesel yield (%)	93	Not applicable

DISCUSSION

The results demonstrate the successful production of biodiesel from the non-edible oil. The increase in yield with catalyst concentration up to an optimum reflects the catalyst's role in accelerating the transesterification reaction, providing more active sites for the conversion of the oil to esters (2, 3). The high yield at the optimum confirms that the reaction proceeded efficiently under the chosen conditions.

The decline in yield beyond the optimum catalyst concentration is attributed to the formation of soap through a side reaction between the excess base catalyst and the oil, which consumes the catalyst and reactants and complicates separation, a well-documented limitation of base-catalysed transesterification (3, 5). This identifies an optimal catalyst loading for maximum yield.

The fuel properties of the biodiesel all met the standard specifications, indicating that it is suitable for use as a fuel. The density and viscosity within limits ensure proper fuel handling and atomisation, the high flash point indicates safe storage, the low acid value reflects good quality, and the adequate cetane number indicates satisfactory ignition (4, 8). The results thus establish the non-edible oil as a suitable, non-competing feedstock for producing biodiesel of acceptable quality (6, 9).

CONCLUSION

This study demonstrated the production and characterization of biodiesel from a non-edible oil by transesterification. The reaction produced a high yield of biodiesel, the yield increasing with catalyst concentration up to an optimum beyond which it declined owing to soap formation, and the fuel properties of the biodiesel met the standard specifications.

The findings establish the non-edible oil as a suitable feedstock for producing biodiesel of acceptable quality by transesterification, avoiding competition with food supply. The fuel offers a renewable and cleaner-burning alternative to petroleum diesel for use in existing engines.

LIMITATIONS

- A single feedstock and catalyst type were studied.
- The effect of catalyst concentration was emphasised over other variables.
- Engine performance and emissions were not evaluated.
- The economics of production were not assessed.

FUTURE SCOPE

- Evaluation of additional non-edible feedstocks and catalysts.
- Optimisation of the alcohol-to-oil ratio, temperature, and time.
- Testing of engine performance and exhaust emissions.
- Assessment of the economic viability of production.
- Investigation of the storage stability of the biodiesel.

REFERENCES

1. Ma, F., & Hanna, M. A. (1999). Biodiesel production: a review. *Bioresource Technology*, 70(1), 1-15.
2. Meher, L. C., Vidya Sagar, D., & Naik, S. N. (2006). Technical aspects of biodiesel production by transesterification: a review. *Renewable and Sustainable Energy Reviews*, 10(3), 248-268.
3. Freedman, B., Pryde, E. H., & Mounts, T. L. (1984). Variables affecting the yields of fatty esters from transesterified vegetable oils. *Journal of the American Oil Chemists' Society*, 61(10), 1638-1643.
4. Knothe, G. (2005). Dependence of biodiesel fuel properties on the structure of fatty acid alkyl esters. *Fuel Processing Technology*, 86(10), 1059-1070.
5. Leung, D. Y. C., Wu, X., & Leung, M. K. H. (2010). A review on biodiesel production using catalyzed transesterification. *Applied Energy*, 87(4), 1083-1095.
6. Sharma, Y. C., Singh, B., & Upadhyay, S. N. (2008). Advancements in development and characterization of biodiesel: a review. *Fuel*, 87(12), 2355-2373.

7. Demirbas, A. (2009). Progress and recent trends in biodiesel fuels. *Energy Conversion and Management*, 50(1), 14-34.
8. Balat, M., & Balat, H. (2010). Progress in biodiesel processing. *Applied Energy*, 87(6), 1815-1835.
9. Atabani, A. E., Silitonga, A. S., Badruddin, I. A., Mahlia, T. M. I., Masjuki, H. H., & Mekhilef, S. (2012). A comprehensive review on biodiesel as an alternative energy resource and its characteristics. *Renewable and Sustainable Energy Reviews*, 16(4), 2070-2093.

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