

Original paper

Comparative Analysis of the Properties of Palm Oil and Palm Kernel Oil Biodiesel from Leventis Farm, Agenebode Edo State

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Received 2 April 2023; Accepted 8 May 2023

ABSTRACT: Biodiesel is a renewable, environmentally friendly, and economically viable alternative to conventional diesel fuel. This study aimed to compare the properties of palm oil and palm kernel oil biodiesel produced from Leventis Farm in Agenebode, Edo State, Nigeria. The research involved the extraction and transesterification of the oils in producing biodiesel and the analysis of the properties of the biodiesel. The analyzed properties include density, viscosity, flash point, pour point, acid value, and cetane number. The density of palm oil biodiesel was 870 kg/m³, while that of palm kernel oil biodiesel was 835 kg/m³. The viscosity of palm oil biodiesel was 6.09 mm²/s, while that of palm kernel oil biodiesel was 3.95 mm²/s. The flash point of palm oil biodiesel was 146 °C, while that of palm kernel oil biodiesel was 120 °C. The pour point of palm oil biodiesel was -3 °C, while that of palm kernel oil biodiesel was -6 °C. The acid value of palm oil biodiesel was 0.48 mg KOH/g, while that of palm kernel oil biodiesel was 0.70 mg KOH/g. The cetane number of palm oil biodiesel was 51.5, while that of palm kernel oil biodiesel was 49.5. The results of the analysis were compared and discussed to determine the suitability of palm oil and palm kernel oil as sources of biodiesel.

Keywords: Biodiesel, palm kernel oil, palm oil, leventis farm

Citation: Suleiman, I. A., Anetokhe M. A., and Anakhu E.A. (2023). Comparative Analysis of the Properties of Palm Oil and Palm Kernel Oil Biodiesel from Leventis Farm, Agenebode Edo State. Direct Res. J. Eng. Inform. Tech. Vol. 11 (4), Pp. 66-69. <https://doi.org/10.26765/DRJEIT98127530215>

INTRODUCTION

Energy is the most fundamental need for human existence and activity in each country (Ali & Mamat, 2013; Mahmud & Cho, 2018). Energy usage rises in tandem with global population growth. Regrettably, the non-renewable energy sources that account for more than 86% of the world's energy supply are running out (Ong et al., 2011; Zahan & Kano, 2018a). Despite being a large producer and exporter of crude oil, Nigeria suffers from a shortage of petroleum products due to corruption and poor sector management (Ali & Tay, 2013a; Gandure et al., 2014). Nigeria still receives its fuel from other

countries. Hence, Nigeria must urgently consider other options for improving its already-devastated economy (Oshewolo, 2012).

Biodiesel is an environmentally friendly, renewable and economically viable alternative to conventional diesel fuel. It is produced from vegetable oils, animal fats or waste oils through a process known as transesterification. Palm oil and palm kernel oil are promising sources for biodiesel production due to their high yields, availability and favourable properties (Ali & Tay, 2013b; Mahmud & Cho, 2018). The use of biodiesel

has several advantages over conventional diesel fuel, including reduced greenhouse gas emissions, improved air quality, and energy security (Ali & Tay, 2013c; Eevera et al., 2014; Silitonga et al., 2016)

Palm oil and palm kernel oil are widely used in the food industry but are also used as feedstocks for biodiesel production (Ali & Tay, 2013a; Ibifubara et al., 2015). Palm oil is a type of vegetable oil extracted from the fruit of oil palm trees, while palm kernel oil is removed from the kernel or seed of the same fruit. The use of palm oil and palm kernel oil as feedstocks for biodiesel production has been gaining popularity due to their favourable properties, which include high energy content, low volatility, and good lubricity (Ishola et al., 2020; Zahan & Kano, 2018b). The research objective compared the properties of palm oil and palm kernel oil biodiesel produced from Leventis Farm in Agenebode, Edo State, Nigeria. The study aimed to determine the suitability of palm oil and palm kernel oil as sources of biodiesel and identify the key factors that influence the properties of biodiesel produced from these oils. The research questions that this study seeks to answer include the following:

- i. What are the properties of palm oil and palm kernel oil biodiesel produced from Leventis Farm in Agenebode, Edo State, Nigeria?
- ii. How do the properties of palm oil and palm kernel oil biodiesel compare?
- iii. What are the key factors that influence the properties of biodiesel produced from palm oil and palm kernel oil?

Several studies have been conducted on the biodiesel properties of palm oil and palm kernel oil. The properties of these biodiesels are affected by several factors, including the feedstock, the extraction and transesterification methods used, and the purity of the biodiesel produced (Ishola et al., 2020; Sylvester & Elijah, 2013). The properties of palm oil biodiesel include high viscosity, high flash point, low pour point, and low acid value (Alamu et al., 2009; Ndana et al., 2011). The properties of palm kernel oil biodiesel include lower viscosity, lower flash point, higher pour point, and higher acid value (Alamu et al., 2009).

MATERIALS AND METHODS

Materials

The materials used in this study included palm oil and palm kernel oil obtained from Leventis Farm in Agenebode, Edo State, Nigeria. The oils were extracted using solvent extraction and transesterified using a two-step acid-base catalyst. The properties of the biodiesel were analysed using standard methods, including density, viscosity, flash point, pour point, acid value, and cetane number (Alamu et al., 2009).

Sampling and sample preparation

Palm and kernel oil samples were obtained from Leventis Farm in Agenebode, Edo State, Nigeria. The samples were stored in a cool and dry place until analysis. Before analysis, the samples were filtered to remove any impurities and water.

Extraction and transesterification of palm oil and palm kernel oil

The extraction and transesterification of the fats were carried out using a two-step acid-base catalyst method. In the first step, the oils were treated with a mixture of methanol and sulphuric acid at 60 °C for 1 hour. The mixture was then cooled and neutralized with a sodium hydroxide solution. In the second step, the mixture was heated to 60 °C and allowed to settle. The biodiesel's top layer was separated and washed with distilled water to remove any residual impurities. The biodiesel was then dried using anhydrous sodium sulphate and stored in a dark container until analysis.

Analysis of biodiesel properties

The properties of the biodiesel samples were analyzed using standard methods. The density of the samples was measured using a density meter. Viscosity was measured using a viscometer. The flash point was determined using a Pensky-Martens closed-cup apparatus. The pour point was measured using a Cloud and Pour Point Apparatus. The acid value of the samples was determined using a titration method. The cetane number was determined using a cetane engine. The data obtained from the analysis of the properties of the biodiesel were used to assess the quality of the biodiesel produced from each oil. The results of the analysis were then compared and discussed to determine the suitability of palm oil and palm kernel oil as sources of biodiesel. The analysis results provided insight into the physical and chemical characteristics of the biodiesel produced from each oil, which are essential factors in determining the suitability of the oils as feedstocks for biodiesel production.

Results

Properties of palm oil biodiesel

The properties of palm oil biodiesel produced from Leventis Farm in Agenebode, Edo State, Nigeria, were analyzed. The analysis showed that the density of palm oil biodiesel was 870 kg/m³, the viscosity was 6.09 mm²/s, the flash point was 146 °C, the pour point was -3 °C, the acid value was 0.48 mg KOH/g, and the cetane number was 51.5.

Properties of palm kernel oil biodiesel

The properties of palm kernel oil biodiesel produced from Leventis Farm in Agenebode, Edo State, Nigeria, were also analyzed. The analysis showed that the density of palm kernel oil biodiesel was 835 kg/m³, the viscosity was 3.95 mm²/s, the flash point was 120 °C, the pour point was -6 °C, the acid value was 0.70 mg KOH/g, and the cetane number was 49.5.

Comparison of properties between palm oil and palm kernel oil biodiesel

The properties of the two biodiesels were compared. The results showed that palm oil biodiesel had a higher density, viscosity, flash point, pour point, and cetane number than palm kernel oil biodiesel. However, palm kernel oil biodiesel had a slightly higher acid value than palm oil biodiesel. Table 1 presents the properties of palm oil and palm kernel oil biodiesel side by side, allowing for comparison. Table 2 highlights the differences between the properties of the two biodiesels.

Table 1: Properties of palm oil and palm kernel oil biodiesel.

Property	Palm oil biodiesel	Palm kernel oil biodiesel
Density (kg/m ³)	870	835
Viscosity (mm ² /s)	6.09	3.95
Flashpoint (°C)	146	120
Pour point (°C)	-3	-6
Acid value (mg KOH/g)	0.48	0.70
Cetane number	51.5	49.5

Table 2: Comparison of properties between palm oil and palm kernel oil biodiesel

Property	Palm oil biodiesel	Palm kernel oil biodiesel
Density (kg/m ³)	Higher	Lower
Viscosity (mm ² /s)	Higher	Lower
Flashpoint (°C)	Higher	Lower
Pour point (°C)	Higher	Lower
Acid value (mg KOH/g)	Lower	Higher
Cetane number	Higher	Lower

DISCUSSION

This study's results show that palm oil and palm kernel oil can be used as sources of biodiesel. However, the properties of the two biodiesels differ, with palm oil biodiesel having better overall properties than palm kernel oil biodiesel. The higher density and viscosity of palm oil biodiesel may make it more suitable for colder climates (Ndana et al., 2011). In contrast, the higher flash point and cetane number may make it more efficient in combustion. The slightly higher acid value of palm kernel oil biodiesel may indicate a lower purity level, but it is still within acceptable limits for biodiesel. These findings are consistent with previous studies that have compared the properties of palm oil and palm kernel oil biodiesel. Overall, this study provides valuable insights into the

properties of biodiesel produced from these two feedstocks and may inform decisions regarding the choice of feedstock for biodiesel production.

Conclusion

The results of this study indicate that high-protein rice flours are a promising alternative to wheat flour to produce cupcakes. The functional properties of the flours, such as the water absorption capacity and water solubility index, were found to be suitable for use in baked goods. The sensory evaluation showed that the panel of judges well-accepted cupcakes made with high-protein rice flour. This study highlights the potential of using locally available high-protein rice flour to produce baked goods, providing consumers with a new source of protein and carbohydrates. In conclusion, developing high-protein rice varieties has increased the potential for using rice flour as a source of both carbohydrates and protein. The results of this study indicate that locally available high-protein rice flour can be used as a substitute for wheat flour in the production of cupcakes. Further studies are needed to investigate the potential of high-protein rice flour in other baked goods and to determine the optimal processing conditions for its use.

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