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PRODUCTION OF BIODIESEL FROM WASTE GROUNDNUT OIL USING CATALYZED TRANSESTERIFICATION REACTION TECHNIQUE.

A. O. Aliyu, O. A. Odueke and S. A. Adeyemi

Department of Chemistry, Tai Solarin College of Education, Omu-Ijebu, Ogun State, Nigeria.
Corresponding author e-mail: tokeomotanwa@ gmail.com

ABSTRACT

Waste groundnut oil can be considered as a potential waste which can be utilized as energy source and raw material for chemical processes. People worldwide use edible oil for cooking which is discarded. The increase in the energy demand was typically provided by fossil fuel, which otherwise are limited and cause serious environmental concern. This study investigated the development of biodiesel from waste groundnut oil using 1.0g KOH catalyzed transesterification reaction technique, in the presence of different concentration of ethanol (80, 60 and 40ml) respectively to produce 180, 140 and 160ml biodiesel at 60^{o}C temperature for 30minutes time. This study shows that production of biodiesel could be a suitable alternative green material to petrodiesel.

Keywords: Waste groundnut oil, catalyzed transesterification, reaction, technique, environmental, biodiesel and petrodiesel.

INTRODUCTION

Biofuel are defined as fuels that are derived from a variety of sources of biomass mainly, it can be classified as biodiesel, bioethanol and biogas. Biofuels are used for plant materials, certain types of crops, recycled or waste vegetable oils. Mainly, biofuels are dominant with energy, and biofuels are power sources from energy [1].

Energy consumption has increased significantly because of the change in lifestyles and growth of population. The increase in the energy demand was typically provided by fossil fuel resources, which, otherwise are limited and cause of serious environmental concerns.[2].

The idea of using alternative fuel has been widely spreading for many years now as a replacement for fossil fuels. The importance of this idea came from the large scale of utilization of fossil fuels in mechanical power generation in various sectors, like agriculture, commercial, domestic, and transport sectors, and also the fact of the continuous rise in fuels cost and their eventual vanishment [3, 4]. Biodiesel is a renewable, clean and environmentally friendly fuel derived from vegetable oils and animal fat [5]. However, it has been reported that the

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cost of the raw materials is about 80% of the total biodiesel production cost [6]. The cheaper waste cooking oil are potential substitutes for vegetable oil in the production of biodiesel. The use of waste cooking oil, as a secondary raw material, provides the additional advantage to reduce, the disposal concerns [7].

The amount of cooking oil produced every year is immense, over 15 million of tons, which if converted, can satisfy to a large extent the world demand of biodiesel [8]. The production of biodiesel from waste vegetable oil allows for a 21% in crude oil saving and 96% in fossil energy saving [9]. So the idea of using waste vegetable oil has been introduced as an economical solution which also gives a waste management solution [10].

Transesterification is a process of transforming triglycerides in vegetable oils into a mixture of fatty acid esters using alcohol and catalyst to speed up this reaction to the right side and to obtain high biodiesel yield methyl or ethyl esters are obtained, with much more similar properties to those of conventional diesel fuels. The main by-product obtained is glycerol. The most common alcohol used for biodiesel production is methanol because of its price and conversion. Other alcohols can be used too, such as plant based ethanol, propanol, isopropanol and butanol [11].

In presence of excess alcohol, the foreword reaction extends beyond the reverse reaction. Many catalysts could be utilized in the process, however, it was confirmed that transesterification is completed faster using an alkali catalyst [12]. Generally, the transesterification reaction involves some critical parameters which significantly influence the final conversion and yield. The most important variables are: reaction temperature and time, free fatty acid content in the oil, water content in the oil, type of catalyst, amount of catalyst, molar ratio of alcohol to oil, type or chemical stream of alcohol, use of co-solvent and mixing intensity[13].

MATERIALS AND METHODS

The waste groundnut cooking oil was a gift from a local fish fryer in Ijebu-Ode Lagos garage in Ogun State.

Preparation of waste vegetable cooking oil

The groundnut cooking oil was used to fry fish for the preparation of waste cooking oil. The waste cooking oil was then transferred into a clean plastic bottle. Later, the waste cooking oil was filtered to remove bits of food residues.

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The filtered clean cooking oil was then collected in a clean conical flask and used for experiments.

Biodiesel preparation

Filtered clean cooking oil was heated up to a temperature of 60^{o}C. It is important not to make overheat the oil above 65^{o}C, because at that temperature alcohol would boil away easily. The heated oil of 630 ml was measured and transfer into clean conical flask. Then we added an excess amount of alcohol to produce process (transesterification reaction see Figure1). The ethanol was used in this process. For improves the transesterification reaction we added KOH as catalyst. The reaction considered starting at this moment, since heated oil assists the reaction to occur. The reaction mixture was then shaken for 30 minutes.

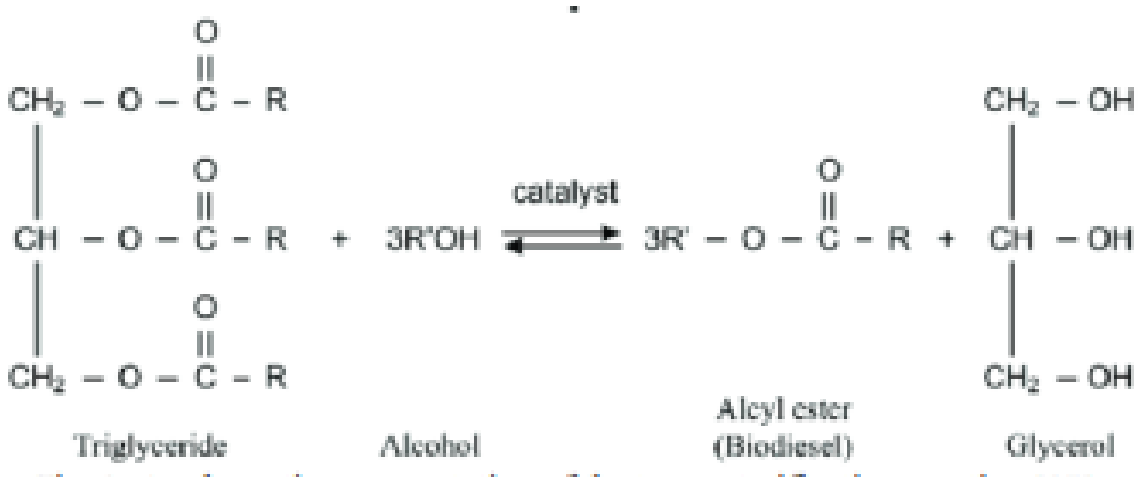

Figure1: A schematic representation of the transesterification reaction [1]

Separation of biodiesel from by-products

The product was then allowed to settle down overnight. Two distinct liquid phases: crude ester phase at the top and glycerol phase at the bottom would be produced in a successful transesterification reaction. There are a few methods to separate these 2 layers, including using the separating funnel and removing the biodiesel using pipette. It was used later in this experiment.

Purification of biodiesel by washing

The top ester phase (biodiesel) was separated from the bottom glycerol phase by transferring to a clean 1000 ml conical flash. The biodiesel was then purified by washing with hot distilled water to remove all the residual by-products like

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excess alcohol, excess catalysts, soap and glycerine. The volume of distilled water added was approximately 15% of the biodiesel volume. This step was divided into two parts in order to verify the importance purification of raw biodiesel by water. In both washing step we added the same volume of water. The flask was shaken gently for 10minute and placed on the table to allow separation of biodiesel and water layers. After separation, the biodiesel was transferred to a clean conical flask.

RESULTS AND DISCUSSION

Table1: The waste groundnut oil - Ethanol-KOH Transterification

Experimental conditions	1st Run	2nd Run	3rd Run
Reaction Temperature (°C)	60	60	60
Reaction time (Minutes)	30	30	30
Waste groundnut oil (ml)	180	200	250
Ethanol (ml)	60	40	80
KOH pellet (catalyst) (g)	1.00	1.00	1.00
Biodiesel produced (ml)	140	160	180
Glycerol (ml)	60	50	80
Losses (ml)	21	11	41
Ratio	1:3	1:5	1:4.5

The biodiesel production has been investigated over studied reactants molar ratios of ethanol to waste groundnut oil from 1:3, 1:5, and 1:4.5, it was evident from Table1 that 1:3 reactant ratio recorded the lowest biodiesel value of 140ml, followed by 1:5, with biodiesel value of 160ml, and the ratio 1:4.5 with 180ml had highest biodiesel value. The increase in alcohol to oil molar ratio above 4.5:1 declines the biodiesel value. This is due to the reversibility behavior of transesterification reaction [15].

CONCLUSION

This study investigated the waste groundnut oil in the production of biodiesel from cheaper raw material, the biodiesel produced is considered as alternative over fossil fuel. The waste groundnut oil biodiesel source is renewable and environmental friendly. Moreover, biodegradable outputs from Industry, agriculture, forestry and households can be used to produce biodiesel as well as representing a paramount opportunity for future development of a sustainable biofuel Industry.

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REFERENCES

1. K.A. Danushka-Thilakarathne, M. Viraj., S.P.R. Udara., N.A. Arachchige., R. Weerasekara., A.J. Randika (2021). Production of Biodiesel from waste cooking oil and Laboratory scale: A Review, *International Journal of Scientific Engneering and Science* **5(6)**: 28-34.

2. M. Sarno and I. Mariagrazia (2019) Biodiesel production from waste cooking oil; *Journal Green Processing and Synthesis* **8 (1):** 828-836.

3. O.J. Alamu., M. A. Waheed, S.O. Jekayinfa and T.A Akintola (2007) Optimal transesterification duration for biodiesel production from Nigeria palm kernel oil ' *Agricultural Engineering International, The CIGR E-Journal*, **9**: 1-11.

4. M. F. Elkady, Z. Ahmed, and O. Balbaa (2015) Production of Biodiesel from waste vegetable oil via KM Micromixer *Journal of Chemistry* **2015**:1-9.

5. P.K. Meka, V. Tripathi and R.P. Singh (2007) Synthesis of biodiesel fuel from sunflower oil using various reaction parameter Journal of Oleo Science **56**: 9-12.

6. S.K. Narwal and R. Gupta (2013) Biodiesel production by transesterification using immobilized lipase *Biotechnology Letter* **35**:479-490.

7. J. Yan, X. Zhang and S. Li (2014) A novel and robust recombinant Pichia pastoris yeast whole cell biocatalyst with Intracellular over expression of a thermonyces, lanuginosus lipase; preparation, characterization and application in biodiesel production, biodiesel production *Bioresour Technology* **151**:43-48.

8. C. Lopresto, S. Naccarato, L. Albo, M. De Paola, S. Chakraborty and S. Curcio (2015) Enzymatic transesterification of waste vegetable oil to produce biodiesel *Ecotoxicol. Saf*. **121** : 229-235.

9. M.C. Bobadilla, R. L. Lorza, R.E. Garcia, F.S. Gomez and E.P.V. Gonzalez (2017) An improvement in biodiesel production from waste cooking oil by applying thought multi-response surface methodology using desirability functions. *Energies* **10**:130.

10. M. C. Math, S.P. Kumar, and S.V. Chetty (2010) Technologies for biodiesel production from used cooking oil- a review *Energy for Sustainable Development* **14 (4):**339-345.

11. Y. Ali, M.A. Hanna and S.L. Cuppett (1995) Fuel properties of tallow and soybean oil esters *Journal of the American Oil Chemists' Society* **72 (12)** : 1557-1564.

12. A.P Singh, B.B. He, J.C. Thompson, and J.H. Van Gerpen (2006) Process optimization of biodiesel production using alkaline catalysts *Applied Engineering in Agriculture* **22 (4):** 597-600.

13. A. Talabiom and K. Kiakilaieh (2013) A review on novel processes of biodiesel production from waste cooking oil In *Applied Energy* **104**: 683-710.

14. A.P. Vyas, J.L. Verma and N. Subrahmanyam (2011) Effects of molar ratio, alkali catalyst concentration and temperature on transesterification of Jatropha oil with methanol under ultrasonic irradiation Advances in *Chemical Engineering and Science* **1(2):**45-50.

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