Transesterification of used frying oil by banana peels waste catalyst for biodiesel production

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ABSTRACT: Realizing a large portion of used frying oil (UFO) is generate daily and a tedious catalyst preparation method, this study aims to investigate the production of biodiesel from UFO by using a one-step hydrothermal carbonization method for catalyst preparation from banana peels waste (BPW). Prior to the reaction, the characteristics of the catalyst were characterized by Scanning Electron Microscope (SEM) analysis, Brunauer, Emmett and Teller (BET) method, and Fourier Transform Infrared Spectroscopy (FTIR) analysis. The catalytic activity of the catalyst towards biodiesel yield was evaluated based on the reaction time and catalyst dosage. The biodiesel yield of 69.23 % was achieves at 120 mins reaction time with 2.5 g of catalyst dosage. In addition, this suggest that the prepared catalyst has a potential to catalyzed UFO although a simple step was used to synthesize the catalyst.

Keywords: *Biodiesel; Used frying oil; Banana peels waste; Agricultural waste; Heterogeneous catalyst*

1. INTRODUCTION

It is vastly understood that the era of fossil fuels will soon be over. Biodiesel is one of a very attractive option to overcome the problem. Furthermore, biodiesel is a clean, safe and non-hazardous due to its biodegradability and carbon neutral nature [1]. To date, the major obstacle in the commercialization of biodiesel is the cost of production which due to the feedstock cost. The used frying oil (UFO) will be helpful for the reduction of the cost [2]. However, good performance of the reaction process will be occurred by the usage of suitable catalyst during the reaction. Therefore, this study is aimed to investigate the potential of banana peels waste (BPW) catalyst in the production of biodiesel from UFO. BPW was chosen as it is abundantly available with a very low in cost [3]. Furthermore, this agricultural waste-based catalyst has been reported for biodiesel synthesis with promising efficacies [4], [5]. However, this material is still under research to come out with a simple preparation method. In this study, a simple one step hydothermal carbonization method has been proposed to investigate the potential of the prepared catalyst in catalysing a biodiesel from low grade of biodiesel feedstock.

2. METHODOLOGY

2.1 Material and chemicals

UFO was obtained from a local restaurant near university's area. KOH (99.99 %) was purchased from Sigma-Aldrich and methanol were supplied by QRec (99.98 %). All chemicals were analytical grade.

2.2 Synthesis of banana peels waste (BPW) catalyst

BPW collected from Banana food stall near Gambang, Pahang. It was first clean and washed to remove dirt and impurities prior dried at 105 °C in the oven for 24 h. After the drying process, it was crash into a small piece of fine powder. Then it was soaked in 1 M KOH solution for 2 h without heating. The mixture was filtered and hydrothermally carbonized at 550 °C for 2 h and denoted as BPW catalyst. Further, the BPW catalyst was characterized through Scanning Electron Microscopy (SEM) analysis, Brunauer, Emmett and Teller (BET) method and Fourier-Transform Infrared (FTIR) spectroscopy technique.

2.4 Evaluation of catalytic activity of banana peel waste (BPW) catalyst

UFO was filtered to remove impurities. Desired amount of methanol was added to heated UFO followed with the desired amount of catalyst added into the mixture and continue to heat at 65 °C. The mixture was mixed vigorously for 120 mins. After completion, the reaction was stopped, and the used catalyst was separated from reaction medium. The mixture was moved to the separating funnel and left for 24 h. In addition, percentage of biodiesel yield was calculated by:

$$\text{Biodiesel yield (\%)} = \frac{\text{Amount of biodiesel (g)}}{\text{Amount of UFO (g)}} \times 100\ \%$$

3. RESULTS AND DISCUSSION

3.1 Characteristics of banana peels waste (BPW) catalyst

To justify the morphology changes of the raw BPW and BPW catalyst activated by KOH, micrographs of both samples were recorded. From the morphological analysis as shown in Figure 1, the raw BPW shows a surface aggregation with a present in pores. However, the aggregation and pore size of the BPW catalyst became smaller after the activation by KOH.

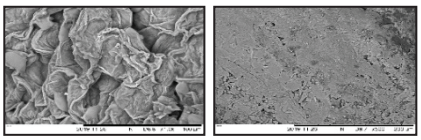

Figure 1 SEM image of raw BPW (left) and BPW catalyst (right).

For the surface area, the result of BET surface area of raw BPW is 4.8203 m^2/g and the result of BET surface area of BPW catalyst is 1.6958 m^2/g. The decreasing of surface areas can be explained by the dehydration process by chemical activating agent.

The surface chemistry of both raw BPW and BPW catalyst were analysed in FTIR spectra as depicted in Figure 2 and 3. Raw BPW and BPW catalyst displayed bands between 3266.23 until 419.09 cm^{-1} and 3131.39 until 672.90 cm^{-1} respectively. As can be seen clearly, several spectrums were absence in BPW catalyst compare to raw BPW. This indicates the catalyst preparation has successfully diminish the impurities content in raw BPW. Therefore, there are only the active groups appeared after the preparation which corresponds for the effectiveness of the catalytic activity to occur.

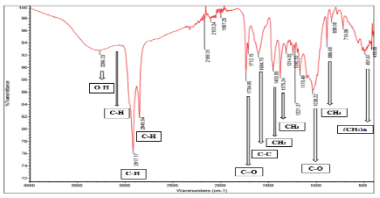

Figure 2 FTIR spectrum of raw banana peels waste (BPW).

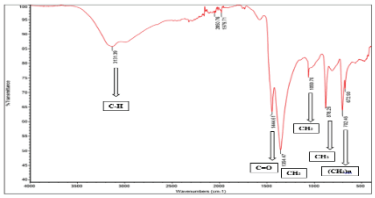

Figure 3 FTIR spectrum of banana peels waste (BPW) catalyst.

3.2 Catalytic activity of banana peels waste (BPW) catalyst

3.2.1 Effect of reaction time

From the finding, it shows that, the reaction was performed at 120 mins with 60 % of biodiesel yield (Figure 4).

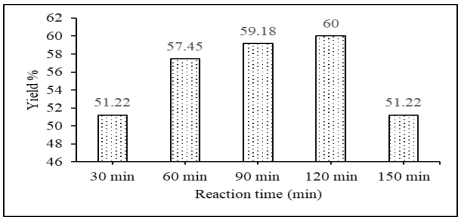

Figure 4 Influence of reaction time on the biodiesel yield using BPW catalyst.

3.2.2 Effect of catalyst dosage

It can be seen obviously from Figure 5; the highest percentage of biodiesel yield is 69.23 % by using 2.5 wt.% of catalyst dosage.

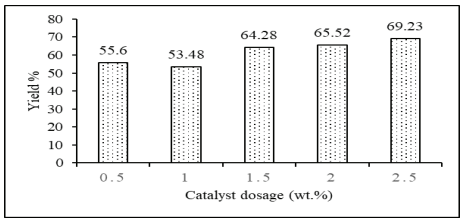

Figure 5 Influence of catalyst dosage on the biodiesel yield using BPW catalyst.

4. CONCLUSION

The production of biodiesel from UFO catalysed by BPW catalyst prepared by one step hydrothermal carbonization method was successfully performed. It can therefore be a low-cost and potential renewable replacement for conventional fuels as a low grade of feedstock with a simple catalyst preparation method was used in the study.

ACKNOWLEDGEMENT

The authors would like to thank Universiti Malaysia Pahang for laboratory facilities as well as additional financial support under UMP Fundamental Research Grant RDU1803167.

REFERENCES

[1] L. Moreno-Garcia, Y. Gariépy, S. Barnabé, and V. Raghavan, "Factors affecting the fatty acid profile of wastewater-grown-algae oil as feedstock for biodiesel," *Fuel*, vol. 304, no. May, p. 121367, 2021.

[2] A. S. Yusuff, A. O. Gbadamosi, and L. T. Popoola, "Biodiesel production from transesterified waste cooking oil by zinc-modified anthill catalyst: Parametric optimization and biodiesel properties improvement," *J. Environ. Chem. Eng.*, vol. 9, no. 2, 2021.

[3] B. Basumatary, S. Basumatary, B. Das, B. Nath, and P. Kalita, "Waste Musa paradisiaca plant: An efficient heterogeneous base catalyst for fast production of biodiesel," *J. Clean. Prod.*, vol. 305, 2021.

[4] M. Gohain, A. Devi, and D. Deka, "Musa balbisiana Colla peel as highly effective renewable heterogeneous base catalyst for biodiesel production," *Ind. Crops Prod.*, vol. 109, no. August, pp. 8–18, 2017.

[5] M. Fan, H. Wu, M. Shi, P. Zhang, and P. Jiang, "Well-dispersive K2O–KCl alkaline catalyst derived from waste banana peel for biodiesel synthesis," *Green Energy Environ.*, vol. 4, no. 3, pp. 322–327, 2019.