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Research Article

Optimization of Biodiesel Production from Sludge of Mask Waste and Used Cooking Oil Using Lipase as Biocatalyst

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Abstract

Mask waste and used cooking oil contain hydrocarbons and free fatty acids. the combination of these ingredients with pretreatment heating in the microwave and the help of lipase enzymes makes the resulting sludge has the potential to be converted into biodiesel with a maximum yield when compared to making biodiesel from other materials and methods. The results of this study indicate that pre-treated sludge from mask waste and used cooking oil can be converted into biodiesel through a methanol transesterification reaction with the help of thermostable lipase enzymes from Pseudomonas. As for the optimum conditions, the highest biodiesel yield was produced at a temperature of 60℃, the best reaction time was 25 minutes, the volume of sludge was 10 mL and the optimum pH was at pH 8. The flame test on the biodiesel produced had been carried out, most of which had bright blue, red flames and orange. There are also some results that the flame is dim and even the test results are not lit.

Keywords: *sludge, biodiesel, mask waste, used cooking oil, lipase*

1. Introduction

Since the beginning of 2020, Indonesia has entered into a new habit order due to the emergence of the COVID19 pandemic, where people must carry out health protocols in their activities, one of these protocols is the obligation to use disposable medical masks, the use should not be more than 4 hours, if it has been 4 hours watch must be replaced with a new mask (Selvaranjan et al, 2021). This situation has led to an increase in the waste of disposable masks in all regions in Indonesia, especially West Nusa Tenggara. There were 1,321 kg of mask waste recorded from March 2020 to December 2021 (NTB Environment Service, 2021). Disposable masks are made of polypropylene (a type of plastic) which takes hundreds of years to decompose. This results in environmental pollution which is certainly not good for living things. So that innovation and technology are needed to process the mask waste (Matin et al, 2022).

On the other hand, Indonesia is threatened with a very serious electrical energy crisis due to limited government funds and the State Electricity Company (PLN) to build electricity infrastructure, investment delays, and the imbalance of high electricity generation costs. According to the Minister of Energy and Mineral

Resources, the development of electricity infrastructure has encountered many obstacles after the economic crisis a few years ago and will be increasingly difficult given the increasing demand for electricity. Even PLN (State Electricity Company) Indonesia has experienced a deficit due to the imbalance in the supply of PLN with the demand for electrical energy by consumers (the public) (Fitra and Asirin, 2020). Currently, the total electricity capacity from PLN has reached 26,000 MW throughout Indonesia, but the peak load has reached 24,000 MW, while the capacity it has is only about 25,000 MW, so that backup electrical energy is barely available. Electricity blackouts in rotation have a huge impact on community activities and the progress of the people, especially in the business world, one of the impacts is the decreasing amount of production which reaches around 30% to above 50% (Pratama, 2020).

This condition is exacerbated by the presence of fossil fuels as a source of energy for power plants which has experienced a very significant decrease in capacity. Based on data from the Ministry of Mines in 2021, the availability of crude oil has decreased by around 30% and has an impact on increasing the selling price of oil and other needs. In fact, petroleum is a non-renewable natural resource, so it takes hundreds of millions of years to get it back (Manurung, 2020).

Therefore, it is very necessary to explore the potential through optimizing the conversion of mask waste to be used as renewable energy in the form of environmentally friendly biodiesel. In this study, pre-treatment will be carried out using used cooking oil and utilizing lipase enzymes as biocatalysts in the process of forming biodiesel.

2. Material and Method

2.1 Material

Test tube, Centrifuge, Microwave, Autoclave, Incubator with shaker, Beaker, Erlenmeyer flask, Pipette, Porcelain cup, Scale, pH meter, Bunsen, Waste Mask, Cooking Oil, Aquades, Lipase Enzyme, Methanol, Citrate Buffer, Phosphate Buffer.

2.2 Methods

Sample Preparation

The mask waste was cut into small pieces, then sterilized using an autoclave at 121℃ for 15 minutes.

Pre-Treatment Process

Cooking oil was added to the sample in a ratio of 1:10 (10gram sample:100gram used cooking oil) then heated in the microwave for 20 minutes. The resulting sludge is used in the optimization process (Jha et al, 2018).

Optimization of Biodiesel Conversion (Sahoo et al, 2019)

a. Sludge volume optimization

This is done by mixing 100 mL of methanol and sludge with varying volumes of 5, 10, 15, 20 and 25 mL, then 0.25 gram of lipase enzyme is added. The mixture was heated for 15 minutes at 50℃and pH 8 (phosphate-buffer citrate).

b. pH optimization

This is done by mixing 100 mL of methanol and 10 mL of sludge volume, then 0.25 gram of lipase is added. The mixture was heated for 15 minutes at 50℃and the pH varied from 6, 7, 8, 9 and 10 (phosphate buffer-citrate buffer).

c. Temperature Optimization

This is done by mixing 100 mL of methanol and 10 mL of sludge volume, then 0.25 gram of lipase is added. The mixture was heated for 15 minutes at various temperatures of 50, 55, 60, 65, 70℃and pH 8 (phosphate-buffer citrate).

d. Time optimization

This is done by mixing 100 mL of methanol and 10 mL of sludge volume, then 0.25 gram of lipase is added. The mixture was heated for various times of 15, 25, 35, 45, 55 minutes at 60℃and pH 8 (phosphate-buffer citrate).

e. Flame test

Biodiesel from each optimization was collected and carried out a flame test using Bunsen (Khalid et al, 2017).

3. Results and Discussion

3.1 Results

Figure 1. Pre-treatmen sludge of mask waste and used cooking oil

pH	Hasil biodiesel (mL)
6	140
7	180

8	185
9	181
10	145

Table 1. Yield of biodiesel volume with variations in pH

Sludge (mL)	Yield of biodiesel (mL)
5	15
10	140
15	135
20	30
25	23

Table 2. Yield of biodiesel volume with variations in sludge

Tempratuture (°C)	Yield of biodiesel (mL)
50	27
55	34
60	76
65	53
70	40

Table 3. Yield of biodiesel volume with variations in temperature and time

Time (minute)	Yield of biodiesel (mL)
15	31
25	77
35	60
45	46
55	43

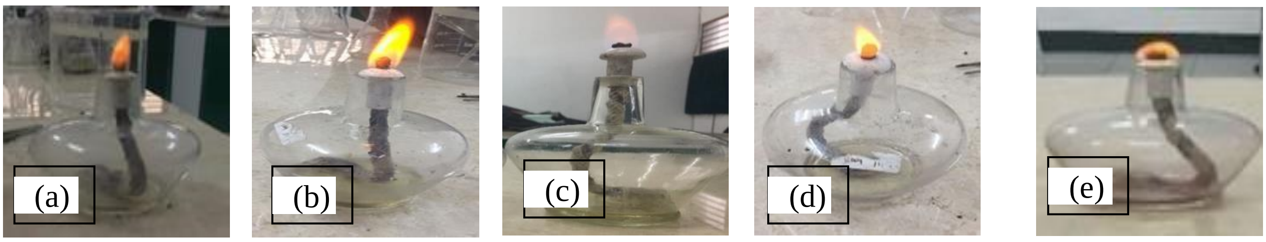

Figure 2. flame test results from variations in temperature (a)70℃, (b)65℃, (c)60℃, (d)55℃, (e)50℃

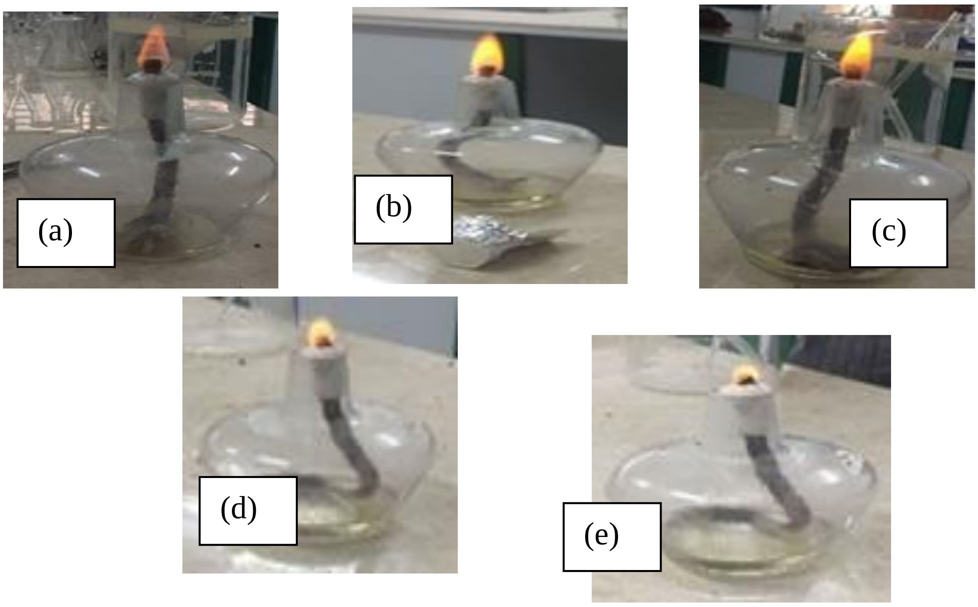

Figure 3. flame test results from variations in time (a)55, (b)45, (c)35, (d)25, (e)15 minute

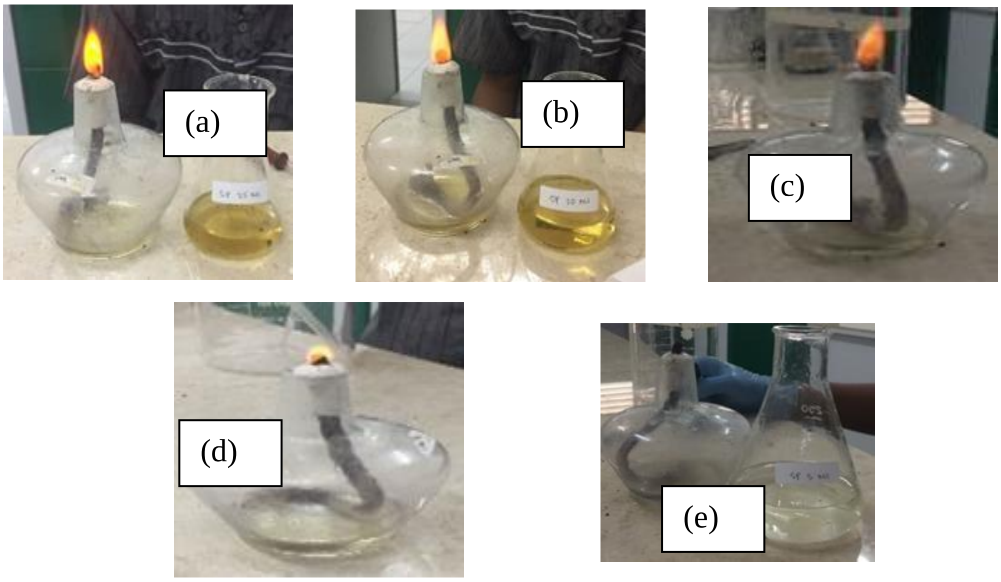

Figure 4. flame test results from variations in sludge (a)25ml, (b)20ml, (c)15ml, (d)10ml, (e)5ml

3.2 Discussion

Pre-treatment of masks and cooking oil in the microwave at 70p/80p. From this treatment, a black sludge was obtained (as shown in Figure 1). If the mask is heated in the microwave without used cooking oil, it will take 40 minutes, but in this study the results obtained sludge in just 20 minutes, this is due to the presence of pre-treatment using used cooking oil. From the results of the pH optimization test in Figure 5, it can be seen that the optimum biodiesel produced is 185 mL at pH 8, this is due to the use of thermostable lipase from Pseudomonas as a biocatalyst, which according to research shows that the lipase can work optimally at pH 8 because it has properties alkaline tolerance (Furqan and Akhmaloka, 2020).

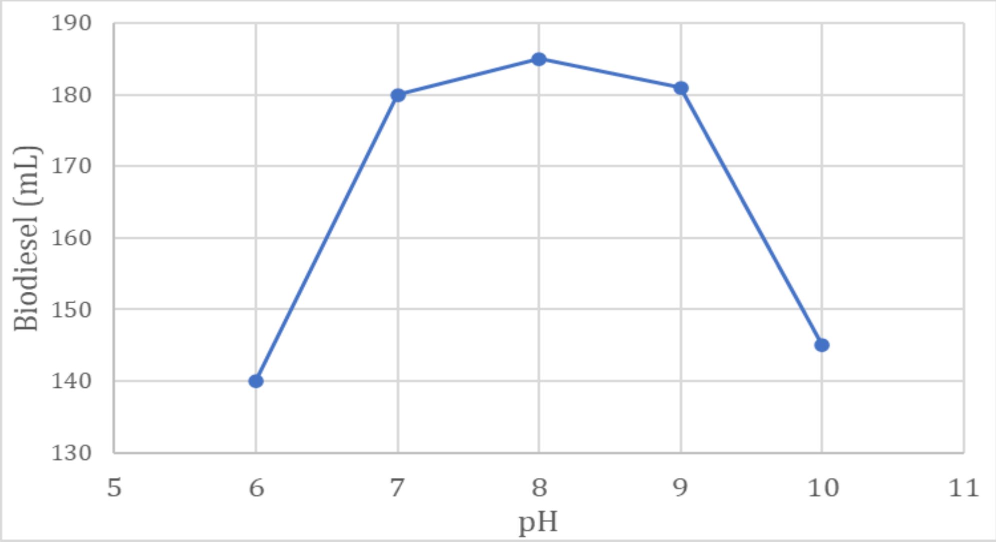

Figure 5. Biodiesel yield graph at various pH

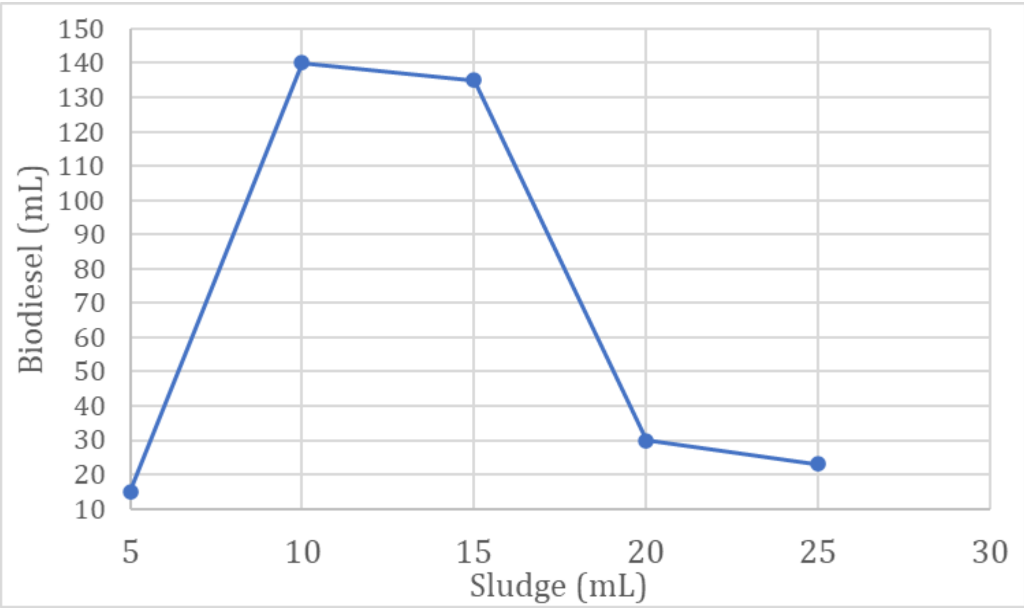

Figure 6. Biodiesel yield graph at various volume of sludge

Furthermore, optimization of the substrate (sludge volume) was carried out using a pH of 8 and a temperature of 50^0C. The optimization results of sludge volume showed that the optimum biodiesel yield was 140 mL at 10 mL sludge volume (Figure 6). This is in accordance with research which states that lipase works optimally on long-chain fatty acids, especially at C12-C14, where 10 mL sludge contains a lot of long-chain fatty acids at C12-C14 (Najjar et al, 2021).

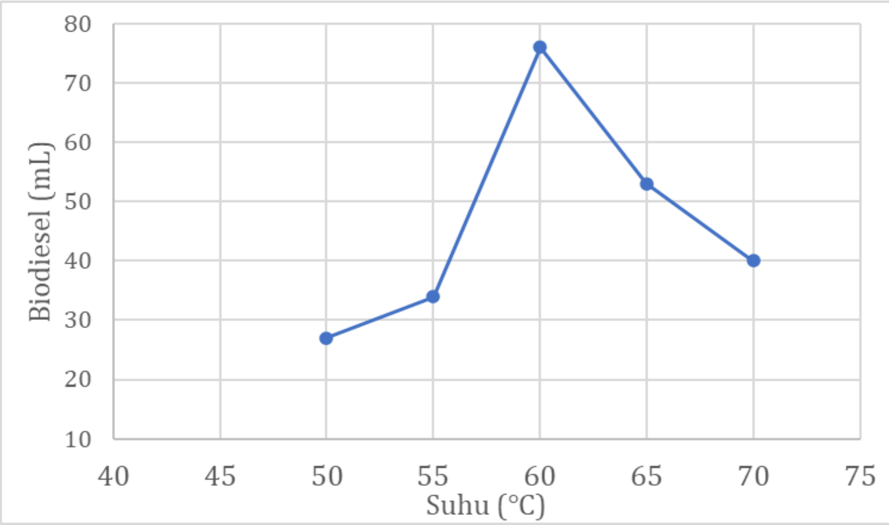

Figure 7. Biodiesel yield graph at various temprature

From the results of the temperature optimization test, it can be seen that the biodiesel yield has an optimum temperature of 60^{0}C. The biodiesel yield increased with increasing temperature up to 60^{0}C although it decreased when the temperature was increased to 65 and 70^{0}C, but the decrease was not significant with biodiesel yield from 76 ml to 53 mL (Figure 7). From this temperature optimization data, it is in accordance with the results of previous research that the use of lipase which is categorized as an optimum thermostable enzyme works at a temperature of 60^{0}C (Shieh et al, 2018).

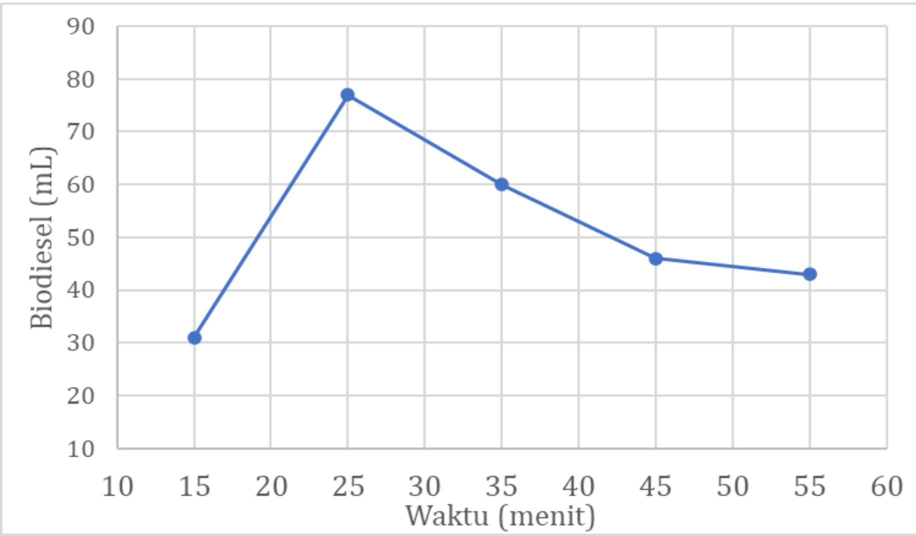

Figure 8. Biodiesel yield graph at various time

The next experiment was carried out by varying the reaction time of mixing sludge, methanol and lipase. The optimum reaction time was obtained at 25 minutes with a biodiesel yield of 70 mL, then decreased not significantly as the reaction time increased to 60 mL at 35 minutes, 46 mL and 43 mL at an increase in reaction time to 45 and 55 minutes (Figure 8). A flame test has also been carried out with the results that most of the biodiesel yields obtained have a positive flame test and some are negative (Figure 2-4). This is due to the quality and quantity of biodiesel produced from each optimization variation condition. This result is reinforced by previous research which also states that the flame or flash point of a biodiesel is influenced by its quality and quantity (Permana et al, 2020).

Conclusion

Optimization has been successfully carried out in the conversion of mask waste and used cooking oil with pre-treatment into sludge, which resulted in the following optimum conditions: optimum sludge volume at 10 mL, optimum temperature at 60℃, optimum reaction time at 25 minutes, and optimum pH at pH 8 A flame test has also been carried out with the result that most of the biodiesel yields obtained have a positive flame test and some are negative.

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