



## Utilization of Used Cooking Oil as a Raw Material for Biodiesel: A Step Towards Renewable Energy

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### ABSTRACT

Used cooking oil, a waste product from the frying process, holds significant potential as an economical and environmentally friendly raw material for biodiesel. This study aims to explore the effect of NaOH catalyst concentration on the transesterification process of used cooking oil in producing biodiesel that meets the Indonesian National Standard (SNI). The research methodology includes the characterization of used cooking oil, variation in catalyst concentration (0.75%, 1%, 1.25%, and 1.5%), and analysis of biodiesel quality, covering yield, viscosity, density, and free fatty acid (FFA) content. The results indicate that a NaOH catalyst concentration of 0.75% produces the highest biodiesel yield (73.9%) and meets the quality parameters in accordance with SNI. This study makes a significant contribution to the development of biodiesel as a renewable energy source in Indonesia.



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## INTRODUCTION

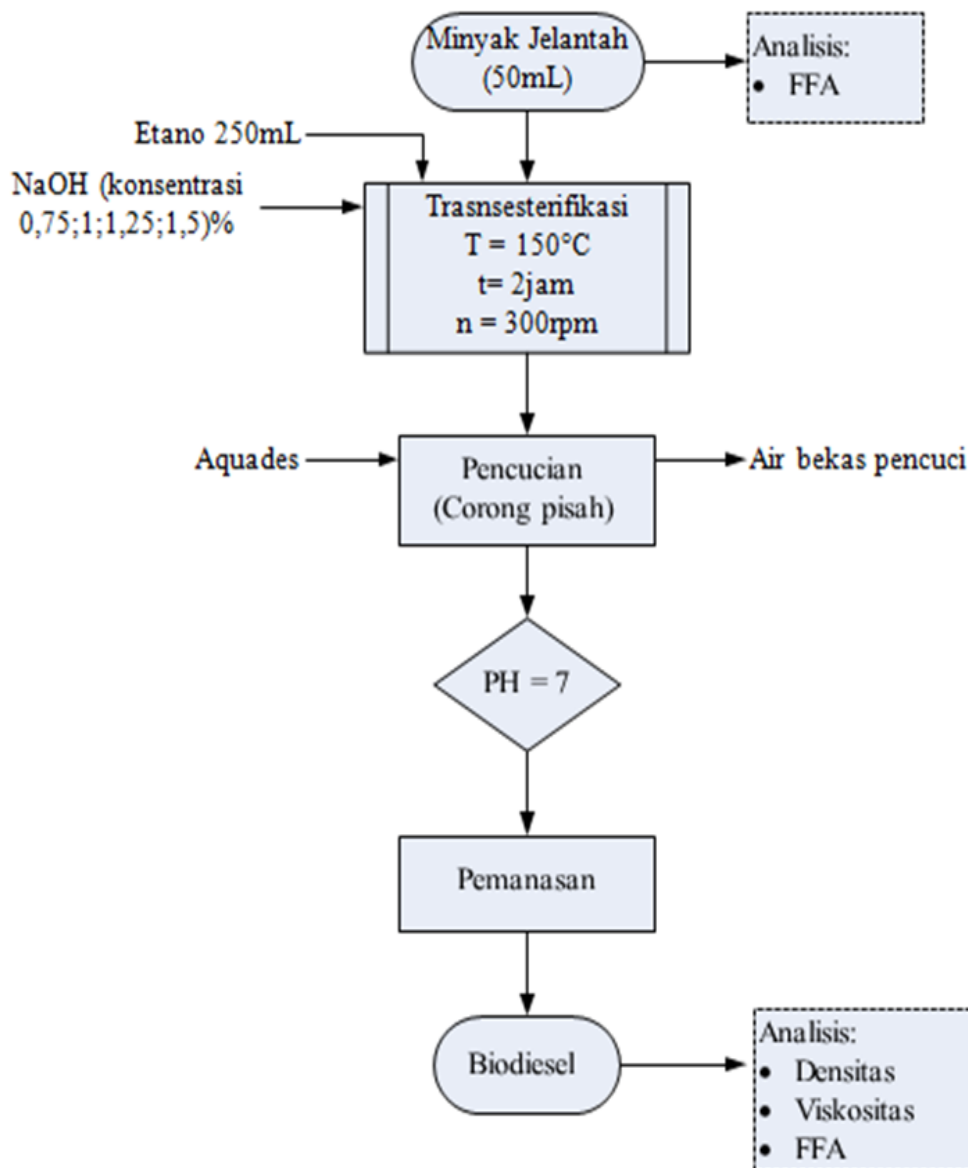
Used cooking oil, a waste product from the frying process, is one of the most affordable and abundant raw materials for biodiesel in Indonesia. With an annual production reaching 3 million tons, used cooking oil is one of the largest domestic waste products that can be utilized for biodiesel development (Putra & Fitriani, 2019). According to Kristiana and Baldino (2021), the potential of used cooking oil as a biodiesel feedstock is substantial due to its widespread availability and low cost. Moreover, biodiesel derived from used cooking oil produces cleaner emissions compared to fossil fuels, offering significant environmental benefits (Nugroho & Wibowo, 2022).

The production of biodiesel from used cooking oil is carried out through transesterification, in which triglycerides in the oil react with alcohol and a catalyst to produce methyl ester (biodiesel) and glycerol. Previous studies have shown that NaOH catalysts can enhance the efficiency of the transesterification reaction and yield high-quality biodiesel (Handayani & Pratama, 2021). Additionally, NaOH has advantages over other catalysts, such as KOH, in terms of lower costs and greater availability. Deng, Li, and Zhao (2022) also noted that NaOH generates minimal chemical residues, making it more environmentally friendly and safer for biodiesel production, thereby offering additional benefits in terms of health and environmental sustainability. However, there is still limited research specifically exploring the optimization of NaOH catalyst concentrations and their effects on the characteristics of the resulting biodiesel.

This study aims to determine the optimal NaOH catalyst concentration in the transesterification process of used cooking oil and to evaluate the quality of the resulting biodiesel based on Indonesian National Standards (SNI). The findings of this research are expected to contribute to the development of cost-effective and sustainable renewable energy.

## RESEARCH METHODS

The process flow diagram for the transesterification of used cooking oil to produce biodiesel is presented in Figure 1.



The transesterification process flow diagram illustrates that:

1. Used cooking oil is characterized to determine its initial properties.
2. The transesterification process is carried out by mixing the oil, ethanol, and NaOH at a specific concentration.
3. The product is separated into biodiesel and glycerol.
4. The biodiesel is purified and tested for quality.

### Materials and Equipment

1. Materials: Used cooking oil, NaOH, 95% ethanol, distilled water.
2. Equipment: Pycnometer, viscometer, separatory funnel, magnetic stirrer, hot plate, UV-Vis spectrophotometer.

### Experimental Procedure

1. Raw Material Preparation: Used cooking oil is characterized to determine the free fatty acid (FFA) content, initial density, and viscosity.
2. Transesterification Process: Used cooking oil is heated to 150°C and then mixed with an ethanol solution containing NaOH at concentrations of 0.75%, 1%, 1.25%, and 1.5%. The reaction is conducted for 120 minutes with stirring at 300 rpm.
3. Separation and Purification: The biodiesel product is separated from glycerol using a separatory funnel, then washed with distilled water until it reaches a neutral pH and heated to remove residual water.
4. Biodiesel Characterization: The resulting biodiesel is analyzed to determine its yield, viscosity, density, and FFA content according to the Indonesian National Standard (SNI).

## RESULTS AND DISCUSSION

### Biodiesel Characteristics

Catalyst Variation NaOH (%)	Parameter			
	Yield (%)	Free Fatty Acids (%)	Density (Kg/m <sup>3</sup> )	Viscosity (mm <sup>2</sup> /s)
<b>SNI Biodiesel</b>	-	<b>2</b>	<b>850-890</b>	<b>2,3-6</b>
0,75	73,9	0,3072	904,3719	4,6
1	72,8	0,4096	901,3457	3,8
1,25	58,5	0,7168	881,1182	2,4
1, 5	66,5	0,6144	882,8804	2,1

The highest yield was obtained at an NaOH concentration of 0.75% (73.9%), while viscosity and density met the Indonesian National Standard (SNI) at a concentration of 1.25%. The relationship between NaOH concentration and biodiesel parameters indicates that increasing the NaOH concentration up to 1% enhances yield and reduces free fatty acid (FFA) content. However, excessive concentrations, such as 1.25% and 1.5%, lead to emulsion formation, reducing the efficiency of the transesterification reaction. The higher FFA content at 1.25% also contributes to a decline in biodiesel quality. The decrease in viscosity and density at 1.25% and 1.5% reflects incomplete triglyceride degradation, preventing the final product from fully meeting SNI standards. The reduced yield at higher concentrations is attributed to emulsion formation during transesterification, which lowers the conversion efficiency of triglycerides into methyl esters.

### CONCLUSION

This study demonstrates that an NaOH catalyst concentration of 0.75% yields the highest biodiesel production (73.9%) with quality that meets the Indonesian National Standard (SNI). Used cooking oil holds significant potential as an economical and environmentally friendly biodiesel feedstock, supporting the development of renewable energy in Indonesia.

### CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

### REFERENCES

- Kristiana, T., & Baldino, C. (2021). Jalur Produksi Bahan Bakar Nabati (Biofuel) Potensial di Indonesia: Gambaran Umum tentang Proses, Bahan Baku, dan Jenis Bahan Bakar. *International Council on Clean Transportation (ICCT)*.
- Handayani, D. A., & Pratama, R. (2021). Optimasi Pembuatan Biodiesel dari Minyak Jelantah Menggunakan Katalis NaOH pada Reaksi Transesterifikasi. *Jurnal Rekayasa Kimia & Lingkungan*, 22(3), 97-105.
- Nugroho, Y., & Wibowo, A. (2022). Pemanfaatan Limbah Minyak Goreng sebagai Biodiesel: Kinerja Emisi dan Efisiensi Energi. *Jurnal Energi Baru dan Terbarukan*, 11(2), 121-130.
- Busyairi, M., Muttaqin, A. Z., Meicahyanti, I., & Saryadi. (2020). Potensi Minyak Jelantah Sebagai Biodiesel dan Pengaruh Katalis Serta Waktu Reaksi Terhadap Kualitas Biodiesel Melalui Proses Transesterifikasi. *Serambi Engineering*, 5(2), 933-940.
- Putra, S. A., & Fitriani, R. (2019). Pemanfaatan Minyak Jelantah Sebagai Bahan Baku Biodiesel dengan Proses Transesterifikasi Berbasis NaOH dan KOH. *Journal of Sustainable Energy Development*, 8(4), 211-220.
- Deng, Y., Li, H., & Zhao, J. (2022). Health and safety considerations of chemically activated carbons: A comparative study of NaOH and other agents. *Sustainable Chemistry and Engineering*, 10(3), 1456-1465.