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# Review The Influence of Adsorption as Pre-Treatment and Dry Washing Methods in Biodiesel Production Using Used Cooking Oil

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***ABSTRACT***

*Biodiesel is an alternative fuel used in diesel engines. Biodiesel can be produced from various types of biomass that exist in nature. Biodiesel processing is the process of converting from triglycerides into fatty acid methyl esters (FAME). The biodiesel production method develops with a variety of processes selected based on the conditions of the raw material and the quality of biodiesel to be achieved. Biodiesel production can use conventional methods such as esterification with acid catalysts and transesterification with base catalysts. Despite there are also new methods such as subcritical and supercritical processes in the absence of a catalyst. The general method of purifying biodiesel is the wet washing and dry washing process, a conventional method for removing biodiesel impurities such as soap, catalysts, glycerol, and alcohol residues using water as a washing agent. Acids can also be used as washing agents, such as phosphoric acid, sulfuric acid, and hydrochloric acid. Dry-washing is a purification method using an ion exchange resin. The biodiesel refining process can also be done using membranes. Besides, there are also ionic liquids and eutectic solvents formed from a mixture of organic halide salts and organic compounds that can be applied in the purification of biodiesel.*

***Keywords:** Biodiesel, Fatty Acid, Dry Washing, and Wet Washing.*

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**ABSTRAK**

Biodiesel merupakan bahan bakar alternatif yang digunakan pada mesin diesel. Biodiesel dapat diproduksi dari berbagai jenis biomassa yang ada di alam. Pengolahan biodiesel adalah proses konversi dari trigliserida menjadi fatty acid metil ester (FAME). Metode produksi biodiesel berkembang dengan berbagai macam proses yang dipilih berdasarkan kondisi bahan baku dan kualitas biodiesel yang ingin dicapai. Produksi biodiesel dapat menggunakan metode konvensional seperti esterifikasi dengan katalis asam dan transesterifikasi dengan katalis basa. Selain itu juga terdapat metode baru seperti proses subkritis dan superkritis dengan tanpa adanya katalis. Metode umum pemurnian biodiesel adalah dengan proses wet washing dan dry washing, suatu metode konvensional untuk menghilangkan kotoran biodiesel seperti sabun, katalis, gliserol dan residu alkohol menggunakan air sebagai bahan pencuci. Selain itu, asam juga dapat digunakan sebagai bahan pencuci, seperti asam fospat, asam sulfat dan asam klorida. Dry washing merupakan metode pemurnian menggunakan resin penukar ion. Proses pemurnian biodiesel juga bisa dilakukan dengan menggunakan membran. Selain itu, juga ada cairan ionik dan pelarut eutektik yang terbentuk dari campuran garam halida organik dan senyawa organik yang bisa diaplikasikan dalam pemurnian biodiesel.

***Kata kunci:** Biodiesel, Purification, FAME, Dry Washing, dan Wet Washing.*

## INTRODUCTION

One of the raw material sources for biodiesel is used cooking oil, which is known to have many advantages. In addition to producing relatively inexpensive fuel, it can also reduce water and soil pollution caused by oil waste often disposed of in drains, and decrease carcinogenic substances in the community. Carcinogenic materials have the potential to trigger colon cancer, kidney issues, and heart disorders. Given the numerous benefits and the high availability of used cooking oil, processing it into biodiesel is a highly appropriate step.

Adsorption is a phenomenon of absorption or enrichment of components from a gas/liquid mixture at the interphase region where the material to be separated is attracted by the surface of a solid. The absorbent material is a solid substance, and absorption occurs only on the surface of the absorbent [1]. In the adsorption process, components remain at the interface and do not enter the phase. The absorbed component is called the adsorbate, while the area where absorption occurs is called the adsorbent (substrate).

However, the Free Fatty Acid (FFA) content in used cooking oil remains high. High FFA levels in biodiesel production can trigger saponification reactions, which result in a decrease in the Fatty Acid Methyl Ester (FAME) content produced. Previous research states that oil with FFA levels above 1% will reduce the yield rate and increase soap formation, making the separation process of biodiesel and glycerol difficult. Other research findings indicate that used cooking oil after six uses can still be economically purified, and semi-automatic processing equipment that is relatively simple has been developed for this purpose.

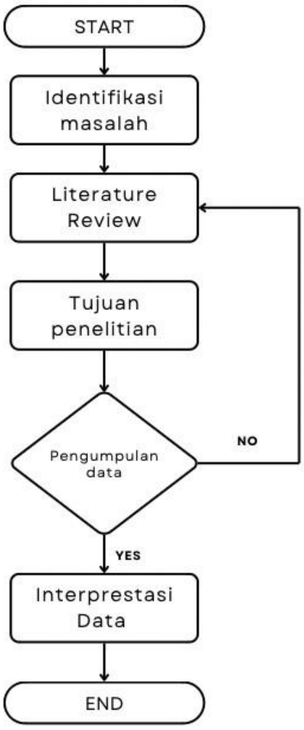
## METHOD

This journal explains the influence of adsorption methods and dry washing methods using used cooking oil as raw material on Free Fatty Acid (FFA) content. The author conducted qualitative research by comparing data related to the chosen topic. To achieve the expected results, the following steps were taken:

The first step involved problem identification regarding the topic of biodiesel. At this stage, the author identified that the type of adsorbent, stirring time, and stirring temperature in biodiesel production using used cooking oil influence the FFA content. The second step was a literature study, where the author reviewed relevant journals based on the topic, specifically focusing on adsorption as a pre-treatment and dry washing methods based on used cooking oil.

The next step was determining the research objectives. The author aimed to determine the effect of adsorption methods, dry washing methods, and variations in temperature and stirring duration on the FFA content in used cooking oil. This was followed by the collection of supporting qualitative and quantitative data based on the topic. The data were collected from scientific journals that are linear to the research topic.

After the data were collected, the author performed data interpretation against the previously established objectives. Based on several supporting journals, it was found that there are differences in the FFA content of used cooking oil when pre-treatment adsorption is combined with dry methods, along with variations in stirring temperature and duration, resulting in different levels of Free Fatty Acids (FFA) in the biodiesel production process. The final step was data reporting, where the collected and interpreted data were compiled into a journal article.




Gambar 1. Flow Diagram of the Qualitative Review Method on the Influence of Adsorption as Pre-Treatment and Dry Washing Methods in Biodiesel Production Using Used Cooking Oil..

## RESULTS AND DISCUSSION

### Discussion of Data I

Based on the results of the research conducted by [2], which compared sugarcane bagasse, kepok banana peels, and bleaching earth as adsorbents, as well as the research conducted by Adhiani et al. regarding the use of H-Zeolite as an adsorbent for the pretreatment of used cooking oil as a raw material for biodiesel, the comparison of the resulting free fatty acid levels after the adsorption process with each type of adsorbent is presented in Table 1.

Tabel 1. FFA Content of Used Cooking Oil After Adsorption

| Data No. | Adsorbent Type | Stirring Time (min) | Stirring Temperature (°C) | Adsorbent Weight (%) | FFA Content (%) |
|---|---|---|---|---|---|
| 1 | Sugarcane Bagasse | 60 | 80 | 13 | 0,49 |
| 2 | Kepok Banana Peel | 60 | 80 | 13 | 0,63 |
| 3 | Bleaching Earth | 60 | 80 | 25 | 0,49 |
| 4 | H-Zeolit | 90 | 90 | 12 | 1,1 |

Based on the data in Table 1 above, using sugarcane bagasse as an adsorbent with a stirring time of 60 minutes and a stirring temperature of 80°C at an adsorbent concentration of 13%, the resulting FFA content was 0.49%. Using kepok banana peel as an adsorbent with a stirring time of 60 minutes and a stirring temperature of 80°C at an adsorbent concentration of 13%, the resulting

FFA content was 0.63%. Using bleaching earth as an adsorbent with a stirring time of 60 minutes and a stirring temperature of 80°C at an adsorbent concentration of 25%, the resulting FFA content was 0.49%. Using h-zeolite as an adsorbent with a stirring time of 90 minutes and a stirring temperature of 70°C at an adsorbent concentration of 12%, the resulting FFA content was 1.1%.

The lowest FFA content was obtained using sugarcane bagasse and bleaching earth adsorbents, which was 0.49%. This may be due to the higher cellulose content in sugarcane bagasse, which is 44.70%, enabling it to absorb impurities and metals. Meanwhile, bleaching earth contains Al3+ ions on its surface that can adsorb dye particles [2].

In adsorption using zeolite as an adsorbent, the FFA content is higher compared to other adsorbents. However, based on research conducted by Adhiani et al., the biodiesel produced from used cooking oil that has undergone adsorption pretreatment with zeolite still meets SNI (Indonesian National Standard) quality standards. The resulting biodiesel yield was 93.64%. The yield of biodiesel from used cooking oil is influenced by the free fatty acid content. The presence of free fatty acids will cause the esterification process to not proceed perfectly. The resulting density was 857.60 kg/m3, which still meets the SNI standard of 850 – 890 kg/m3. The moisture content was 0.02%, still meeting the SNI standard of a maximum of 0.05%. The acid value was 0.29 mgKOH/g, which still meets the SNI standard of a maximum of 0.8 mgKOH/g. This low acid value indicates that free fatty acids have been successfully removed through pretreatment (adsorption process). According to other researchers, an excessively high acid number is undesirable because, at high temperatures, free fatty acids can react with metals such as iron, zinc, lead, manganese, cobalt, tin, and other metals, which can accelerate damage to diesel engine components. The iodine value was 15.71, still meeting the SNI standard of a maximum of 115. The cetane number was 75.62, which still meets the SNI standard of a minimum of 51 [3].

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## CONCLUSION

Based on the research results conducted by Trisnaliali et al. (2019) and Adhiani et al. (2016) regarding the use of various types of adsorbents for the pretreatment of used cooking oil as biodiesel raw material, it can be concluded that the use of sugarcane bagasse and bleaching earth adsorbents yielded the lowest FFA levels after the adsorption process, at 0.49%. This can be attributed to the high cellulose content in sugarcane bagasse, which enables it to absorb impurities and metals. Meanwhile, kepok banana peels produced an adsorption FFA level of 0.63%, slightly higher than sugarcane bagasse and bleaching earth. H-Zeolite resulted in a higher FFA level of 1.1%, although the biodiesel produced still met SNI standards with a yield of 94.64%. Stirring time and temperature influence adsorption effectiveness. For instance, H-Zeolite with a stirring time of 90 minutes and a temperature of 70°C produced higher FFA levels compared to other adsorbents. Cellulose content, Al3+ ions, and the chemical characteristics of the adsorbent contribute to the adsorption capacity for FFA..

## REFERENCES

[1] Mayuni, S. N., Suaniti, N. M., & Manuaba, I. B. P. Karakterisasi Biodiesel Dari Minyak Jelantah Menggunakan Pereaksi Bioetanol Tetes Tebu.

[2] Trisnaliani, L., Jaksen, Ridwan, K. A., & Fitriyanti, D. (2019). Pretreatment minyak jelantah dengan menggunakan adsorben sebagai bahan baku biodiesel. J*urnal Kinetika*, 10(03), 19– 24.

[3] Adhani, L., Aziz, I., Nurbayti, S., & Oktaviana, C. O. (2016). Pembuatan biodiesel dengan cara adsorpsi dan transesterifikasi dari minyak goreng bekas. J*urnal Penelitian dan Pengembangan Ilmu Kimia*, 2(1), 71-80.