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# Effectiveness of Activated Carbon CaCl2 and NaNO3 Reducing Fatty Acids and Increasing the Quantity of Biodiesel Production

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**Abstract:** The study aims to identify the ability of carbon activated $CaCl_2$ and $NaNO_3$ in reducing fatty acids in jelah oil in biodiesel synthesis. This research is an experimental research with a quantitative descriptive approach. The variables measured in this study are the acidity level and quantity of biodiesel production from used cooking oil. The instruments used in this study include PH meters and Gas Cromatography mass Spectoscopy (GC-MS). The pH meter is used to measure the acid concentration of used cooking oil after going through a filtration process using activated carbon $CaCl_2$, $NaNO_3$, and inactivated carbon. The GC-MS instrument is used to identify the quantity of biodicell production made from used cooking oil. The data obtained are presented in the form of tables and graphs to identify the effect of the treatment given. Based on measurements of PH meters and GC-MS activated carbon CaCl2 is proven to be able to reduce fatty acids from an initial pH of 4 to 7 and get a biodicell of 100%. Based on these finding, it can be concluded that. Use of $CaCl_2$ activated carbon has provev to be the most effective in reducing fatty acids and increasing the quantity of biodiesel production.

**Keywords:** Activated Carbon; Biodiesel; Fatty acids

## Introduction

Edible fats and oils also called simple lipids contain 95-98% triacylglycerol, small amounts of diasyl and monoacylglycerol, free fatty acids, and 1-2% non-soapable components, such as sterols, tocopherols, and color compounds (Abidin 2013; Awogbemi et al., 2019). Cooking oil is mostly composed of triacylglserol. Cooking oil is a basic need that is almost consumed every day. The intake of oils resulting in a variety of metabolic disorders in the body. The onset of problems in metbolism in the body will have implications for the emergence of various diseases (Kimura et al .,2020; Marino et al. 2021).

Cooking oil that is often used by the Indonesian people, especially the lower middle class, is bulk oil. The affordable price is the dominant reason this cooking oil is widely used by the public. Many people are not aware of the impact of using bulk cooking oil in the long term. Cooking oil that is continuously used to fry food at high temperatures causes a break in the bond in the oil (Bhatnagar et al. 2009; Liu et al. 2019). Free radicals and fatty acids cause various diseases in our bodies (Choe & Min, 2006; Gordon & Magos, 1983; Jiang et al., 2020; Rossi et al., 2007; Xie et al., 2019). Diseases such as hypertension and cancer can appear if they consume bulk oil for a long period of time (Mouodi et al., 2019; Zhuang et al., 2021). Cholesterol in cooking oil is one of the triggers for the emergence of various diseases. High cholesterol levels trigger the onset of heart failure (Karminingtyas et al., 2021; Park & Han 2021; Surtini and Badriyah 2021).

Blood with high cholesterol also has implications for the brain's workability (Silva et al., 2020). A large amount of evidence supports that the gut microbiota plays an important role in the regulation of metabolic, endocrine, and immune functions. Inrecent years, it has been found the involvement of the gut microbiota in

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several neurochemical pathways through the interconnected gut-brain axis. Fats or oils not only contain negative values, fats are also a source of energy for the body.

Fats of a certain concentration are needed as a source of energy. (Kimura et al., 2020) states asam fat synthesized as an energy substrate. Long- and medium-chain fatty acids derived primarily from dietary triglycerides, and short-chain fatty acids produced by the fermentation of gut microbes from indigestible dietary fiber, are the main sources of free fatty acids. Recently, a growing body of evidence suggests that fatty acids not only serve as a source of energy but also as natural ligands for a group of protein receptors. (Ormazabal et al., 2018) stated that the effect of insulin suppression on diadiposit lipolysis causes an increase in free fatty acids. The increase in prudence free fatty acids stimulates the peraand secretion of fatty acids resulting in hypertriglyceridemia. Triglycerides are transferred through the *cholesteryl ester process of protein transfer*. This process produces triglyceride-enriched cholesterol particles on glucose metabolism, insulin resistance leads to a decrease in the synthesis of liver glycogen, due to a decrease in the activation of glycogen synthesis .

Fatty acids have such a far-reaching impact on our health. Fats that are not decomposed into energy for the body will accumulate in the body which causes various diseases in the body (Barrea et al. 2019; Kunz et al. 2019; Lee et al. 2022; Lee at al. 2019). Literacy about fatty acids in used cooking oil that is low in Indonesian society causes negative impacts on cooking oil consumption, many are not known by the public. The conversion of used cooking oil into biodiesel is important as a way to reduce its negative impact. Biodicell synthesis is important in the midst of a fossil energy crisis and the environmental impacts caused. The abundance of sawait plantations in Indonesia has become a big capital in making biodiesel. Triglycerides are staples in biodicell dressing (Corro et al. 2017; Long et al., 2021). Triglycerides are commonly found in palm and legume plants (Chatterjee et al. 2020; Sankararaman & Sferra 2018). Biodicell synthesis mostly uses vegetable trigesides. (Changmai et al., 2020) reported the use of plant-based triglycerides proved to be more effective and efficient in producing biodicells by producing homogeneous and heterogeneous catalysts.

Used cooking oil cannot be directly obtained into biodiesel because it contains free fatty acids (Gardy et al., 2017; Sahar et al., 2018; Wang et al., 2017). The presence of free fatty acids in the oil causes a stinging reaction (Ardiyanti et al., 2020; Bouaid et al., 2016; Glass RL 1971). The stinging reaction at biodicell synthesis causes low biodicell yield. Technology is needed in removing fatty acids in used cooking oils. One technique to reduce fatty acids is the addition of active carbon (Hernandez et al., 2018; Yang et al., 2017). (Niu et al., 2018) reported that sulfanilate-activated carbon was shown to be able to reduce free fatty acids produced by biodiesel with levels of 96%. The addition of an activator to carbon is needed to attract residues in used cooking oil. (Kastner et al., 2012) stated that sulfite-activated carbon can catalyze the esterification reaction of fatty acids with a yield of 90-10%. (Capson-Tojo et al., 2018) found the use of granular activated carbon has been shown to be effective in lowering acetic acid levels in the decomposition of organic waste. The process of decomposition of organic waste by microorganisms produces by-products in the form of acetic acid. If the concentration of acids continues to increase the work of microorganisms in decomposing organic waste may be disturbed. The ability of activated carbon to absorb acids is very useful in keeping the activity of microorganisms running. Based on the description above, the use of activated carbon is important to continue to be developed in reducing fatty acids in used cooking oil. Decreased levels of fatty acids in oil can reduce the negative impact of oil on health and can improve the quantity of the biodiesel produced.

## Method

The main ingredients used in this research are used cooking oil, methanol 96% pro-analyst, KOH pro-analyst, coconut shell carbon. Glassware, magnetic strirrer, gas chromatography mass spectrometry, pH meter. The process of making biodiesel from used cooking oil starts from the filtration of used cooking oil using filter paper and activated carbon. Furthermore, the manufacture of methoxy by reacting 50 mL of methanol with 1 gram of KOH. The next step is the transesterification process, separation of biodiesel from glycerol, washing biodiesel, drying, and testing biodiesel using the GC-MS instrument. The data obtained are then arranged in tables and described in the form of graphs. The graph is used to be able to see the effect of the application of activated carbon in reducing the fatty acids of used cooking oil and increasing the percentage of biodiesel production.

## Result and Discussion

The process of making biodiesel from used cooking oil starts from the filtration of used cooking oil using filter paper. This process is carried out to separate used cooking oil macro residues. The next process measures the pH of the oil using a pH meter. Subsequently, a second filtration was carried out using activated carbon CaCl2, NaNO3 and unactivated carbon, respectively. All filtrates were measured pH to see the ability of carbon in reducing fatty acids. The results of the identification of the pH of used cooking oil can be seen in Table 1.

**Table 1.** pH of used cooking oil on several filters

| Filtration | Filter paper | Activated carbon (CaCl2) | Activated carbon (NaNO3) | Unactivated carbon |
|---|---|---|---|---|
| pH | 4 | 7 | 6 | 5 |

The next process is used cooking oil which has passed the second filtering stage and is then made into biodiesel. Biodiesel is made from 250 mL of used cooking oil that has gone through the second filtering stage plus 50 mL of methoxy solution. Methoxy solution was prepared from 50 mL of methanol plus 1 gram of KOH. All ingredients are mixed in a glass beaker and then heated on a hot plate magnetic stirrer at a temperature of 65-75 0C for 1-2 hours. After 2 hours the ingredients are put in a separating funnel. The material is allowed to stand for 10-15 minutes until two layers are formed. the top layer of biodiesel and glycerol in the bottom layer.

**Table 2.** % Biodicell area and Unbiodiesel Carbon filtarized are not activated.

| Peak | Area% Biodiesel | Area% Unbiodiesel | Name |
|---|---|---|---|
| 1-2 | 3.43 | 0.00 | Tetra acid, methyl ester |
| 3-4 | 35.99 | 0.00 | Hexadecanoiic acid, metyl ester |
| 5 | 0.00 | 2.50 | Hexadecanoiic acid, palmitatic acid |
| 6&8 | 0.00 | 46.31 | 9-octadecanoic acid |
| 7 | 9.45 | 0.00 | Octadekanoid acid, methyl ester |
| 9&10 | 2.34 | 0.00 | Eicosenoice acid, methyl ester |
| Total | 51.21 | 48.81 | |

The separated biodiesel is then washed with warm water at a regular temperature of 65-75 0C, washing is carried out to clean fatty acids or other minerals dissolved in biodiesel (Abbaszadeh et al., 2014; Atadashi et al., 2011; Pinho et al., 2022). Furthermore, biodiesel is heated at 1300C for 10-15 minutes to evaporate water during the biodiesel washing process (Chozhavendhan et al., 2020; Fonseca et al., 2019). Furthermore, the composition of biodiesel was measured using a gas chromatography mass spectrometry (GC-MS) instrument.

The test results using the GC-MS instrument and a pH meter showed that the main compound formed was actadecanoic acid. The octadecanoic acid contained in the sample was 48.7%. Octadecanoic acid and palmitic acid are fatty acids that are quite common in used cooking oil. (Mozzon et al., 2020; Muanruksa et al., 2020; Sarno & Iuliano, 2019). This result is relevant to the pH measurement in Table 1 which shows an acidic pH. Based on table 1-3, used cooking oil filtered with CaCl2 had the most positive impact on biodiesel synthesis. The test results showed the lowest pH and the biodiesel concentration obtained was 100%.

**Table 3.** % Area of Biodicell and Unbiodiesel Stabilized Carbon Activated $NaNO_3$.

| Peak | Area% Biodiesel | Area% Unbiodiesel | Name |
|---|---|---|---|
| 1 | 0,62 | 0 | Dodecanoic acid methyl ester |
| 2 | 2.31 | 0 | Tetradenoic acid, metyl ester |
| 3 & 4 | 25.65 | 0 | Hexadecanoiic acid, palmitatic acid |
| 5 | 40.54 | 0 | 9-octadecanoic acid methyl ester |
| 6 | 8.42 | 0 | Octadekanoid acid, methyl ester |
| 7 & 8 | 1.68 | 0 | Eicosenoice acid, methyl ester |
| 9 | 0 | 4.57 | 1-Triacontanol |
| 10 | 0 | 16.26 | 1-hexacosanol |
| Total | 78.60 | 20.83 | |

**Table 4.** % Area of Biodicell and Unbiodiesel Stabilized Carbon Activated $CaCl_2$

| Peak | Area% Biodiesel | Area% Unbiodiesel | Name |
|---|---|---|---|
| 1 | 2.10 | 0 | Tetradenoic acid, metyl ester |
| 2 | 34.17 | 0 | Hexadecanoiic acid, palmitatic acid |
| 3 | 54.97 | 0 | 9-octadecanoic acid methyl ester |
| 4 | 8.76 | 0 | Octadekanoid acid, methyl ester |
| Total | 100 | 0 | |

Test results for biodiesel on used cooking oil filtered using activated and non-activated carbon are described in full in graph 1. Figure 1 illustrates the most effective CaCl2 activated carbon degrading fatty acids. The decrease in fatty acids was also recorded at the pH of used cooking oil after undergoing a filteration process as shown in graph 2. If we look closely, the decrease in fatty acids is inversely proportional to the increase in biodiesel production from used cooking oil. The increase in fatty acids will have an impact on the saponification process in biodiesel (Glass RL 1971; KunWu et al., 2022). If a saponification reaction occurs, it can disrupt the transesterification reaction, which will result in a decrease in biodiesel production. The results of treatment with CaCl2 activated carbon filter proved to be the most effective in reducing fatty acid levels, the most effective indicators were the pH of used cooking oil and the concentration of biodiesel obtained. The pH indicator describes the concentration of acid dissolved in used cooking oil. The relationship between pH and fatty acids can be seen in Graph 2.

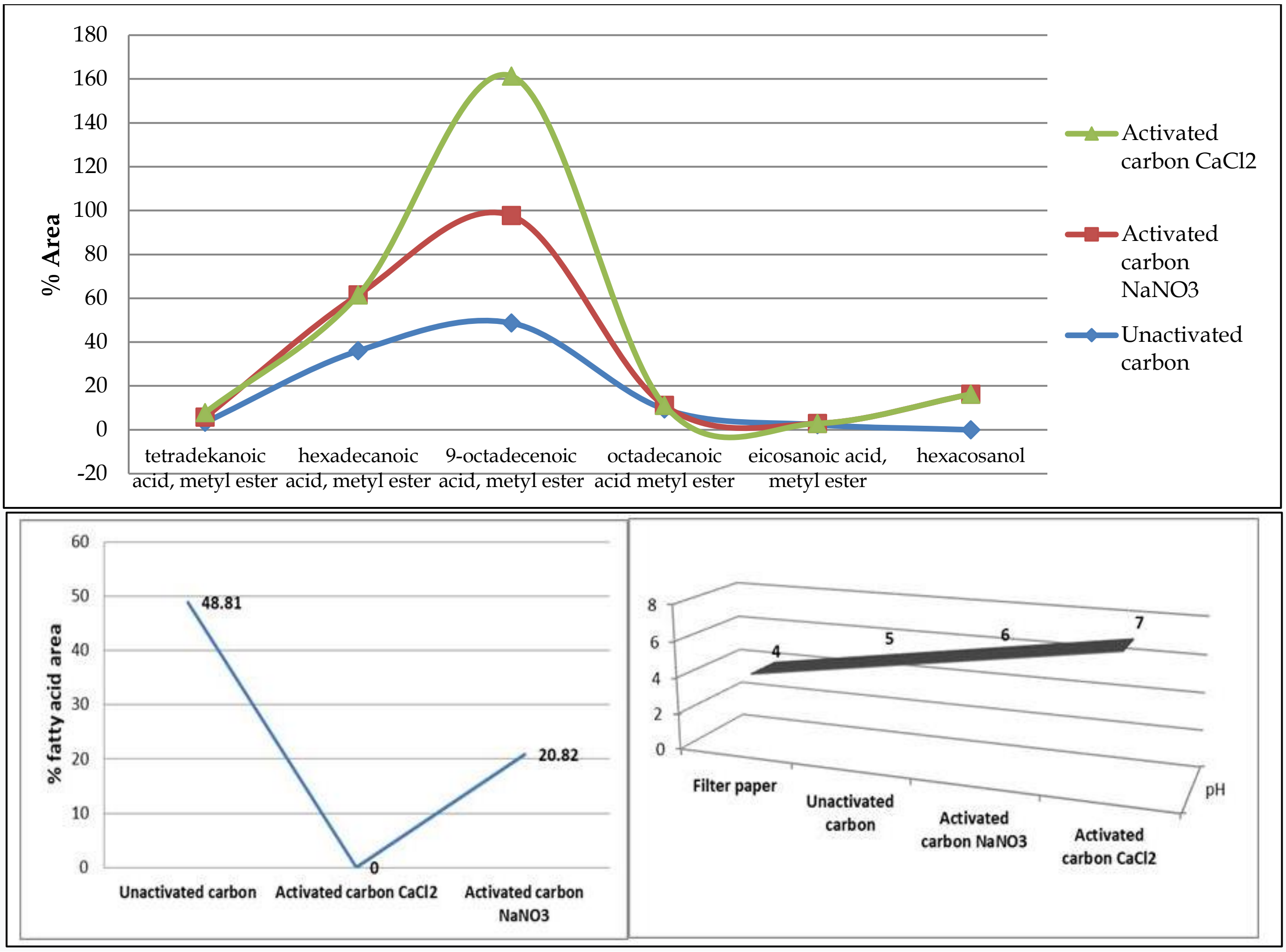


**Figure 1.** Biodicell Profile of Activated Carbon Filtered Used Cooking Oil

The biodiesel results were confirmed even more clearly from the results of the mass spectrometer (MS) instrument test. This instrument is one of the instruments that is able to read organic molecules dissolved in the sample. This instrument is able to read the molecular mass and its fragments after going through the electron firing process (Glish and Vachet 2003). The test results can be seen in spectra 1 and 2. These results reinforce the finding that used cooking oil contains high fatty acids. Octadecanoad and palmitic acids being the acids with the highest concentrations are found in the cooking oil. Used cooking oil used is oil sourced from palm oil. The findings of many researchers in palm oil contain a lot of palmitic, octadecanoad and citric fatty acids (Albuquerque 2020; Bahadi, Salih, and Salimon 2021; Muanruksa et al., 2020).

These results are relevant to the researchers' findings when the sample is included in the GC-MS instrument. A mass spectroscopy instrument is an instrument capable of reading the molecular structure of a sample. The molecular structure is read through the process of shooting electrons on the molecule through the instrument. Furthermore, the molecule undergoes fragmentation into positive and negative ions. The GC-MS test results provide an overview of the relative molecular mass and segmented positive ion molecules. The results of the GC-MS test can be seen in the chromatogram below. The results from the MS instrument showed that the molecular mass of several compounds in biodiesel from used cooking oil was 242, which indicates the molecular mass of meristatic acid. Another name for meristic acid is tetradecanoic acid.

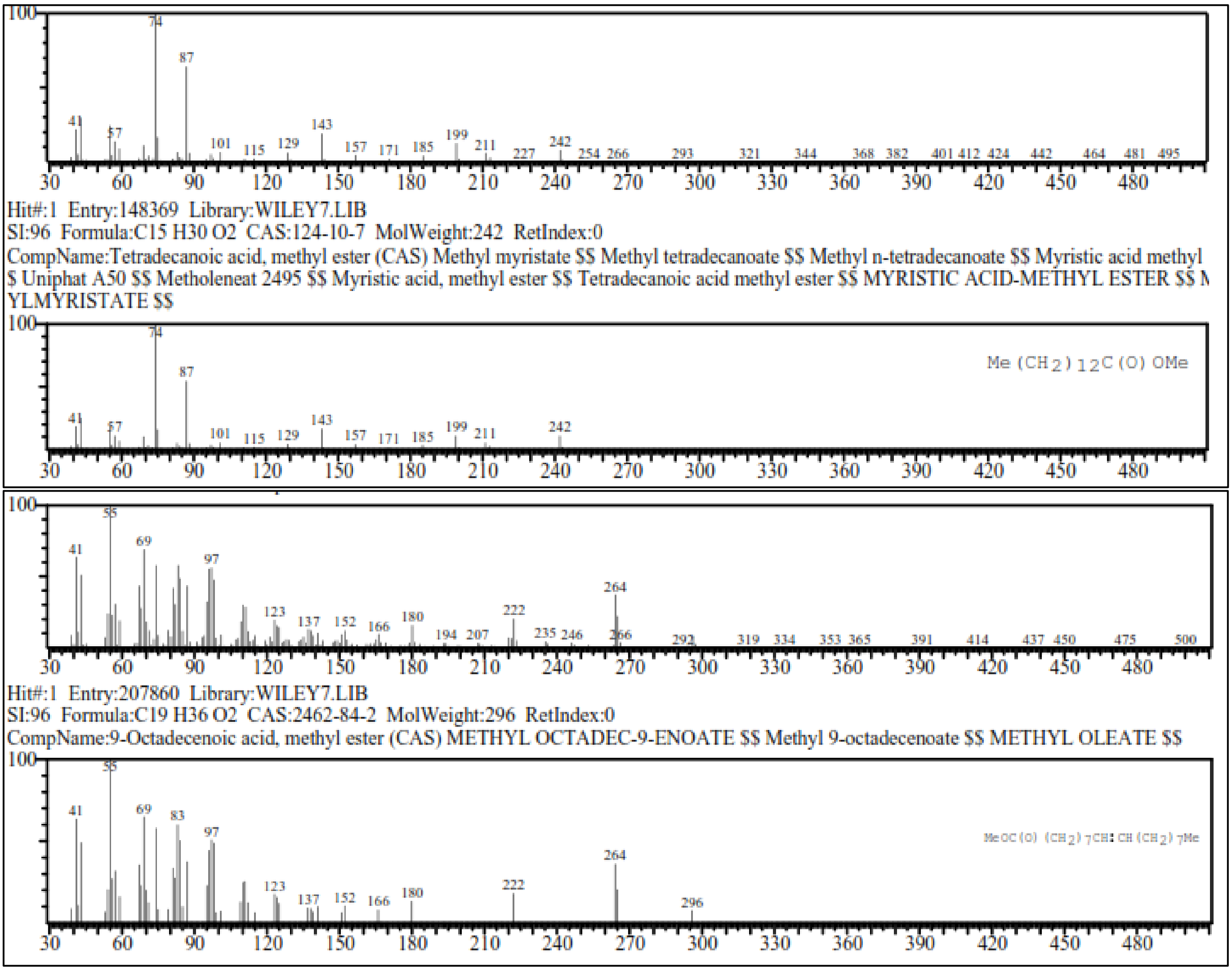


**Figure 2.** Spectrum of used cooking oil biodiesel components

The above test results show that the most abundant biodiesel component is octadecanoid acid methyl ester. This result can be seen from the 54.97% area which is the largest of the other ester components. Based on the GC-MS test, it was obtained that the molecular mass was 296 g/mol, representing oleic methyl ester. The used cooking oil used is palm oil, which is evident from the highest meristic and oleic acid content obtained when the samples were tested. Meristic and oleic acids are the most common organic acids found in cooking oil made from palm oil (Bukhari et al., 2020; Rattanaporn et al., 2018). Based on the test results using a pH meter and GC-MS the application of CaCl2 activated carbon proved to be effective in reducing organic acids and increasing the quantity of biodiesel production from used cooking oil.

## Conclusion

The application of CaCl2 activated carbon proved to be the most effective in reducing fatty acids and increasing the quantity of biodiesel production from used waste cooking oil.

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