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Red Clam Shell based Basic Heterogenous Catalyst for Transesterification of *Ricinus communis L* Oil

Synthesis and Characterization

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ABSTRACT
The transesterification process in synthesizing biodiesel utilizes basic catlalyst to enhance the reaction. This research investigated the use of red clam shell based basic heterogenous catalyst for biodiesel production from *Ricinus communis L* oil. The purpo21se of this research was to optimize the heterogenoeus catalyst synthesis and comprehend the synthesized catalyst characterization. Red clam shell powder was prepared through 750°C, 800°C and 850°C calcination temperatures for 4 hours. The synthesized heterogeneous catalysts were characterized through SEM, XRD and FTIR in order to comprehend the morphology, its content and the present functional groups existed. It was founs out that the red clam shell ash had porous structure with its regularity increases with increasing calcinating temperature. Besides, according to XRD analysis the porous material with the highest amount of CaO presented was determined to be at 800°C calcination temprature to be 92.6% alongwith $CaCO_3$ indicating the basic properties. Moreover, the functional groups presented on heterogeneous catalyst were observed to be CaO as the sharpest peak was at 3653.82 cm^{-1} and $CaCO_3$ at 1452.40 cm^{-1}, 1004.91 cm^{-1} and broad peak around 500 cm^{-1} with 800°C calcination temperature. Two percent of 800°C calcinated catalyst was utilized for transesterification with 1:8 oil to methanol ratio at 60°C reaction temperature. It was figured out that the synthesized biodiesel exhibited 4.587 x 10^{-3} Pas and 0.878 kgm^{-3} as its viscosity and density respectively. The use of red clam shell based catakyst for *Ricinus communis L* oil transesterification for biodiesel production was proven to be potential and demands further study on its application for transesterification reaction.

Keywords: *Heterogeneous catalyst, Red clam shell, Ricinus communis l, Transesterification.*

1. INTRODUCTION

The public, especially upper middle class individuals, is in considerable demand for seafood products including shellfish, clams, and others. Many eateries and vendors sell seafood meals, luring patrons in to partake of the available seafood menu. Increased seafood production has the unintended consequence of producing more garbage, which is bad for the environment. Since it takes a while for seafood waste to organically decay, environmental pollution is inevitable.

Indonesia's fuel oil stocks are rapidly running out and are predicted to be depleted in 10 to 15 years. Most of Indonesia currently suffers from a lack of electricity supplies. The availability of gasoline, gas, coal, and power is limited[1,2]. Generating alternative energy sources is one strategy to solve the issue of energy scarcity. Biodiesel is one of these energy sources.

For use in diesel engines, biodiesel is defined as mono-alkyl esters of long-chain fatty acids made from renewable sources of fat, such as vegetable oils and animal fats. The usage of biodiesel can solve a number of issues, including helping to prevent the coming energy crisis. Additionally, in an effort to promote the investigation of eco-friendly alternative fuels.

An annual plant that can withstand drought is ricinus communis L. This plant can also thrive in hot, arid, and rocky environments and grow fast and robustly. Lowlands up to an altitude of 3000 meters above sea level are favorable for cultivation. Because its seeds generate oil, which is used as a basic material to produce biodiesel, this plant can be valuable economically[3]. Many different vegetable oils have been used in research on biodiesel substitute fuels. As an illustration, the United States uses soybean oil as a raw material, Europe uses rapeseed oil, and tropical nations use palm and coconut oils[4]. The chemical industries that produce paint, varnish, lubricants, printing inks, cosmetics, perfumes, pharmaceuticals, pulp and paper factories, as well as the nylon and plastic industries, use *Ricinus communis l* extensively[5].

Utilizing it as a source material for heterogeneous base catalysts like CaO is one way to get around this issue. Through the $CaCO_3$ calcination process, shellfish and oyster shell waste can be used as a source of CaO catalyst. [6] reported that clam shells have a CaCO3 content of 98.7% of the total mineral content, making them a very promising source of CaO catalyst for the manufacture of biodiesel. Green energy, also known as biofuels or biofuels, is energy that originates from living plants (biomass) that are all around us. This serves as the context for research being done on the transesterification process of producing biodiesel from castor oil utilizing a calcium catalyst made from shell waste.

2. METHODS

2.1. Equipments and Materials

The used equipments are as follows:

1. Beaker
2. Erlenmeyer Flask
3. Separatory funnel
4. Mortar
5. Sieve mesh
6. Oven
7. Muffle furnance
8. Stirrer
9. Three neck rounded flask with condensor
10. Deccicator
11. GC-MS
12. SEM
13. XRD
14. FTIR

The used materials are as follows:

1. *Ricinus communis l* oil
2. Clam shell (*anadara granosa*)
3. Methanol (Merck)
4. KOH (Merck)
5. *Isopropyl alcohol*
6. Phenolphthalein indicator
7. *Potassium hydrogen pathalat* (php)
8. Acetone
9. Aquadest

2.2.Methodology

2.2.1. Catalyst Preparation

In order to prepare catalyst, the following procedure was committed:

1. The catalyst in this investigation was CaO powder made from calcined blood clam (Anadara granosa) shell waste.
2. Clean blood clam shells are pounded in a mortar and calcined for a specified amount of time and at a specified temperature.
3. The shells are sieved through a 200 mesh sieve after the calcination phase is complete, cooled in a desiccator, and then kept inside again.

2.2.2.Transesterification

Ricinus communis l oil was poured into three neck vessel then heated until 60°C. The prepared catalyst was dissolved itno methanol. The two solutions were mixed and stirred at 350 rpm for 60 minutes. After the reaction was reached, the solid particles were separated with separatory funnel before being left for 24 hours.

2.2.3.Purification

After being synthesized, biodiesel containing mixture is then purified through distillation process. This process was conducted in order to separate methanol and water from biodiesel.

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2.2.4.Characterization and Testing

The produced biodiesel by the transesterification process and followed by the purification process then carried out the analysis process which is the dependent variable in this study. The analysis that will be carried is as follows:

1. Yield
2. Density
3. Viscosity
4. Water content
5. Acidity

1. Biodiesel composition Analysis (GCMS)
2. Analysis on X-Ray Diffraction (XRD)
3. FTIR test
4. SEM test

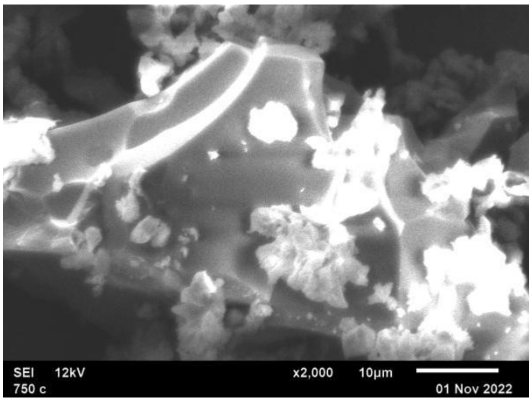
3. RESULTS AND DISCUSSION

3.1. Clam Shell Catalyst Synthesis

The prepared shells are used as raw materials for the synthesis of solid powders which are useful as catalysts in transesterification reactions. In the catalyst synthesis process, the refined shell powder is calcined at various temperatures from 750°C to 850°C.

3.2. Catalyst Morphological Analysis

The synthesized catalyst powder with various calcination temperatures was then characterized to determine its properties as a catalyst. SEM or Scanning Electron Microscopy provides information regarding the morphology of the synthesized catalyst solids or powders. Figure 1 shows the SEM results of the synthesized catalysts.



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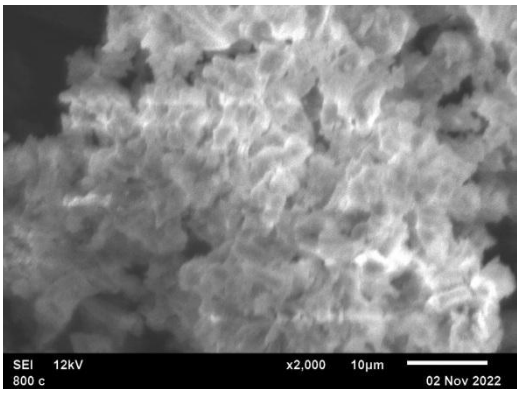

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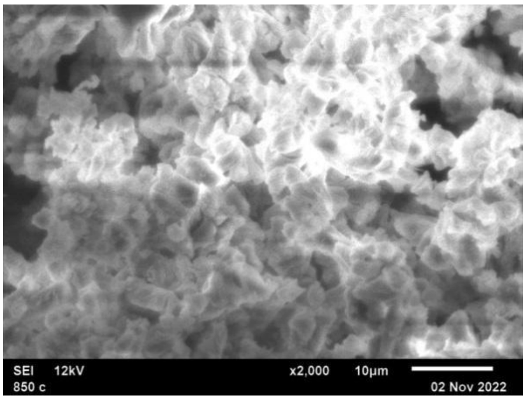

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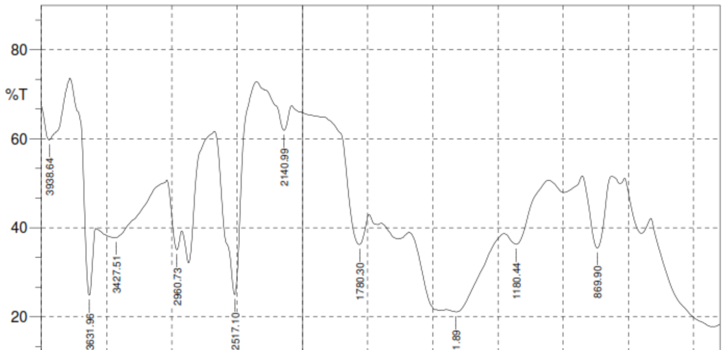
Figure 1. SEM analysis on clam shell based catalyst with 2.000 x magnification (a) calcination temperature of 750°C (b) calcination temperature of 800°C (c) calcination temperature of 850°C

Figure 1 shows the changes in the structure of the synthesized solid or powder catalyst which becomes more regular with increasing calcination temperature. This can be explained by the increasingly regular and uniform conversion of CaCO3 to CaO. In addition, the particle size is also getting smaller which can have an effect on increasing contact with the reactants when the reaction involving the catalyst takes place.

3.3. Catalyst Functional Groups Analysis

Functional groups analysis on the synthesized solid catalyst is useful to determine the presence of functional groups on the catalyst which is useful for accelerating the transesterification reaction. Figure 2 shows the FTIR test results of a solid catalyst synthesized from clam shells.



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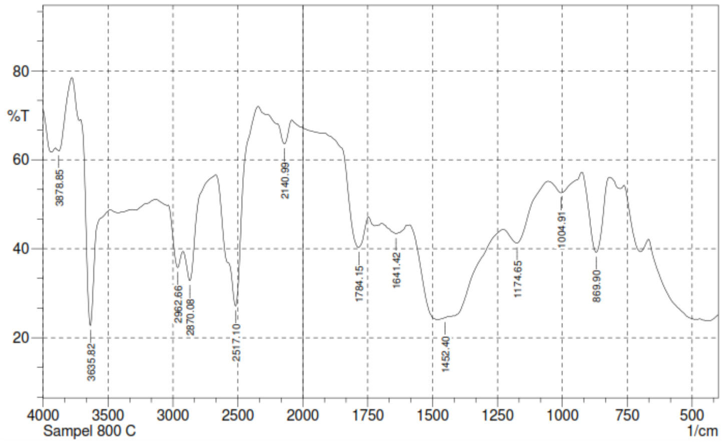

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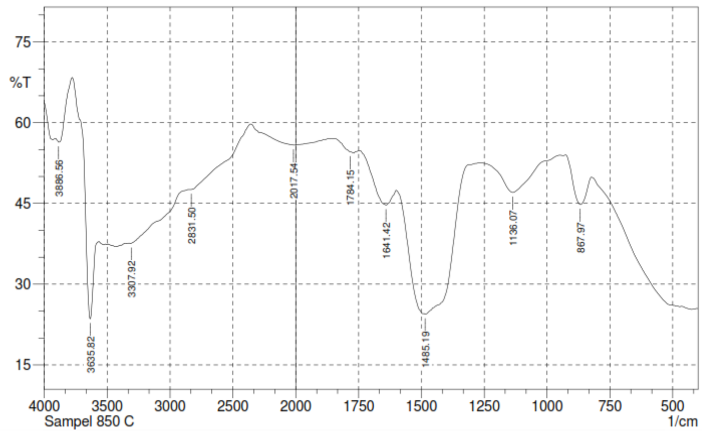

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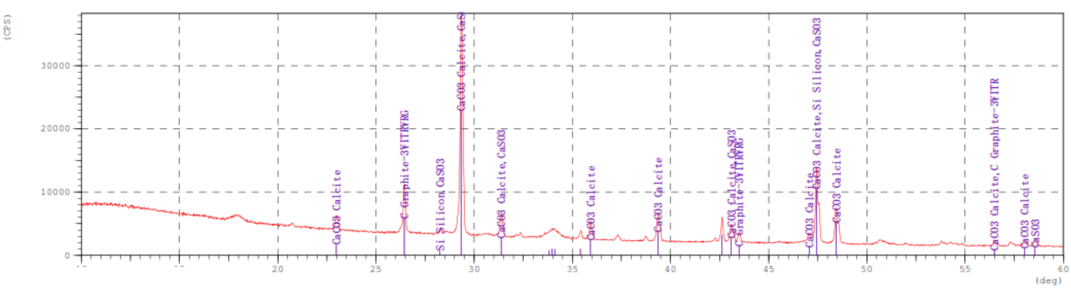
Figure 2. FTIR analysis on clam shell based catalyst (a) calcination temperature of 750°C (b) calcination temperature of 800°C (c) calcination temperature of 850°C

Figure 2 shows the similarity of the three prepared catalysts. The presence of the CaO functional group which is useful as a catalyst in the transesterification reaction peaks in the range of 3600 cm^{-1} to 3650 cm^{-1}. Of the three samples, the sharpest peak was shown and the highest intensity was shown in the sample with a calcination temperature of 800°C. In addition, $CaCO_3$ was also shown in the three samples with peaks in the range of 1450 cm^{-1} to 1500 cm^{-1}, 860 cm^{-1} and smaller than 500 cm^{-1}.

3.4. Catalyst XRD Analysis

The analysis on crystallinity of synthesized catalyst is shown in Figure 3.



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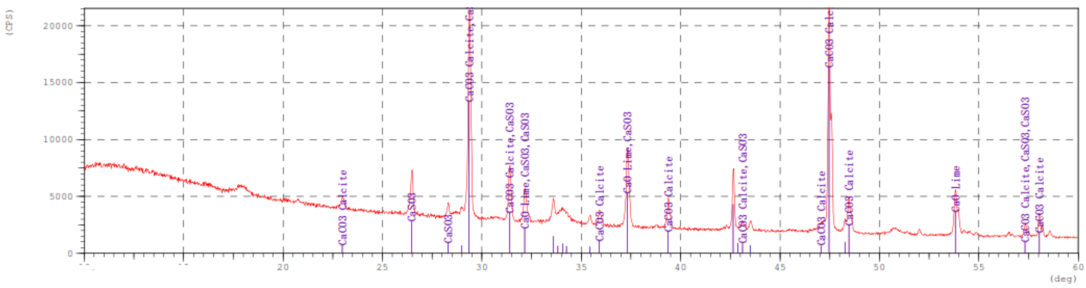

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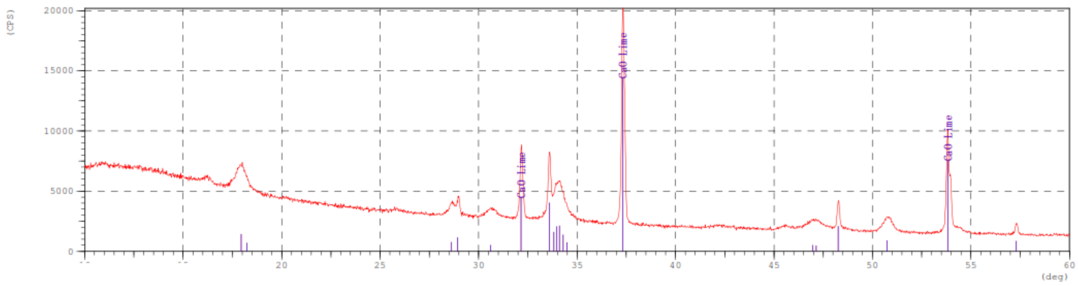

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Figure 3. XRD analysis in clam shell based catalyst (a) calcination temperature of 750°C (b) calcination temperature of 800°C (c) calcination temperature of 850°C

Figure 3 shows the structure of the synthesized catalyst in the form of a positivity which can increase the adsorption intensity of the material on the catalyst. In addition, the highest synthesized CaO compound was shown at a calcination temperature of 800°C, namely 92.6%, followed by a calcination temperature of 850°C, 92.2% and 88.7% at a calcination temperature of 750°C.

3.5. Synthesized Biodiesel Analysis

Two percent of 800°C calcinated catalyst was utilized for transesterification with 1:8 oil to methanol ratio at 60°C reaction temperature. The use of utilized catalyst was due to the its highly potential use for biodiesel synthesis. It was figured out that the synthesized biodiesel exhibited 4.587 x 10^{-3} Pas and 0.878 kgm^{-3} as its viscosity and density respectively.

4. CONCLUSIONS

The use of clam shell waste is potential as catalyst in transesterification reaction for biodiesel production. The caharacteriztion of synthesized catalyst has supportive morphological properties as catalyst with its presented functional groups on the porous surface. Furhtermore, the produced biodiesel with syntesized catalyst showed its properties to be in the range of standardized properties.

AUTHORS' CONTRIBUTIONS

The first author acted as coordinator to the team for other authors. Besides, there are students who assisted the research team in performing series of research sets in laboratory.

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