

**BIODIESEL PRODUCTION FROM RUBBER SEED OIL USING
CALCIUM OXIDE DERIVED FROM EGGSHELL AS CATALYST-
OPTIMIZATION STUDY.**



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Presentation Outline

- Introduction
- Problem Statement
- Aims and Objectives of Study
- Research Methodology
- Results & Discussion
- Conclusion & Recommendations
- References



Introduction

- Various fossil fuels such as oil, coal, natural gas, etc are being depended upon by the worlds present economy.
- The excessive consumption of fossil fuels especially in large urban areas, has resulted in the generation of high level of pollution over the years.
- The anticipated scarcity of fossil fuels prompted the search for petroleum derivative substitutes.
- This search resulted in the discovery of an alternative fuel known as "biodiesel."
- Biodiesel is the alkyl ester of fatty acids produced by the transesterification of oils or fats derived from plants or animals with short chain alcohols such as methanol and ethanol.



Problem Statement

- The cost of biodiesel is a main obstacle to commercialization of the product.
- The extensive use of edible oils for biodiesel production may lead to food crisis.
- These problems can be solved by using low cost feedstocks such as non edible oils and waste cooking oils for biodiesel production, in this case, Rubber Seed Oil (RSO) is being used.



Aim and Objectives

Aim:

The aim of this project was to evaluate the performance of RSM on the optimization of the biodiesel from rubber seed oil using calcium oxide derived from egg shell as catalyst.

Objectives: The objectives of this research project include:

- a) Obtaining biodiesel from rubber seed oil through esterification and transesterification method.
- b) To determine the optimum yield of biodiesel using RSM tool.
- c) Optimizing the process parameters involved in the extraction of biodiesel from rubber seed oil using RSM.



Literature Review

- The rubber tree (*Hevea brasiliensis*), commonly known as the Para rubber, is the most economically significant member of the genus *Hevea* and is native to the Amazon region of Brazil in South America.
- Rubber got its name after English scientist Joseph Priestley discovered that it could erase pencil marks on paper in 1770.
- Africa accounts for roughly 9.5 percent of the world's proven crude oil reserves, which are concentrated in four nations (Nigeria, Algeria, Egypt, and Libya), and produces about 12 percent of the world's oil
- Africa may commercialize the production of biofuels to diversify its energy and agricultural activities, lessen its reliance on crude oil, and promote sustainable economic growth.



Literature Review

- Egg shell, which is primarily made of calcium carbonate, has the potential to be used as a raw material in the manufacturing of biodiesel. Some of the chemical composition of egg shell are CaO , MgO , Na_2O .
- A catalyst is a chemical that influences a reaction's rate, whether it's a positive or negative one, without being significantly impacted by the activity.
- Transesterification of acyl glycerol (triglyceride) in vegetable oils and animal fats with short chain alcohols (in this work, methanol) produces biodiesel, a long chain fatty acid mono-alkyl esters (FAME).
- The primary raw materials required for the synthesis of biodiesel are lipids and simple alcohols.



Materials and Method

MATERIALS

- Methanol (CH_3OH).
- Ethanol ($\text{C}_2\text{H}_5\text{OH}$).
- Sulphuric Acid (H_2SO_4).
- Rubber Seed Oil (RSO).
- Eggshells.

MATERIALS

- Phenolphthalein indicator.
- Potassium hydroxide (KOH).
- Hydrochloric acid (HCL).
- Starch indicator



Materials and Methods

Catalyst Preparation

The dirt was entirely removed from the raw eggshells by a vigorous water wash, which was followed by spreading them out to dry in the sun. Using a grinding device, the dried shells were reduced to a fine powder. To create calcium oxide, the finely ground shells were heated to 900°C in an oven for 4 hours. In the transesterification process, the final product created by calcination serves as a catalyst.

Biodiesel preparation

Pre-treatment of raw oil (Esterification Procedure)

The RSO was treated with methanol while being exposed to sulphuric acid as a catalyst to lower the FFA. In this process, initially 50 ml of feedstock was preheated to 60°C, and this is followed by esterification reaction at a temperature of 65°C as cited in literature. After the reaction is completed, the treated oil is separated from excess methanol-catalyst mixture in a separating funnel. The esterified oil thus prepared was used for all the transesterification studies.



Materials and Methods

Transesterification Procedure

After esterification, the esterified RSO was poured into a conical flask. The catalyst prepared was mixed with methanol to form methoxide by stirring and then the formed methoxide was poured into the oil. The methoxide-treated RSO mixture was placed on the constant temperature magnetic stirrer. The methoxide-treated RSO mixture was left for a particular period of time and at specific temperature following the experimental design modelled by Box-Behnken. The formed product was transferred to a separating funnel through filter paper to separate the catalyst from the transesterification products, and the solution was set aside for 48 h to separate. After perfect separation, the two layers are visible in the separating funnel, of which the bottom layer is glycerol which is drawn out and the top layer is the fatty acid methyl ester (FAME) which is called biodiesel. The procedures were repeated for 28 more runs.

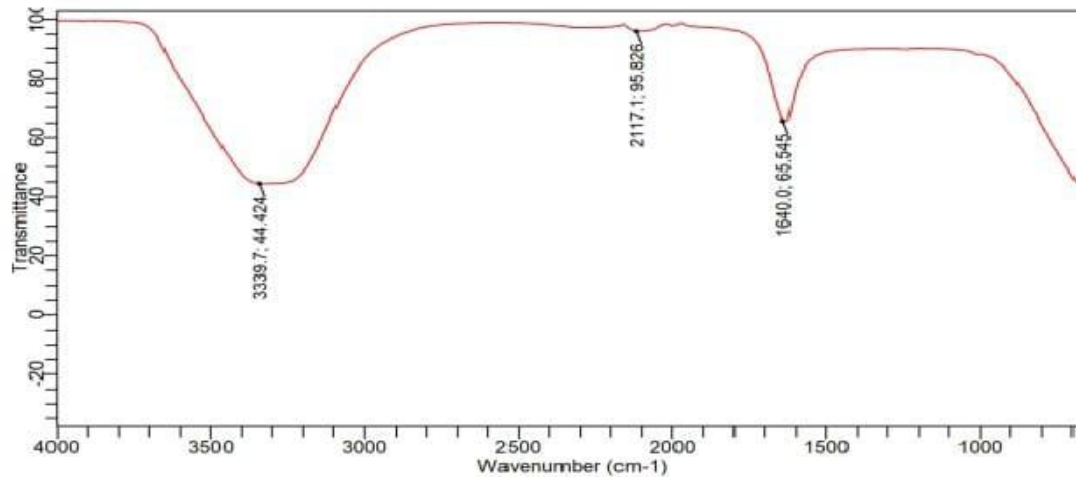


Results and Discussion

CHARACTERISATION OF THE PREPARED CATALYST

- **Fourier Transform Infrared Spectroscopy (FTIR)**

FTIR analysis helped to identify the various functional groups that were present in the calcined egg shells. According to the FTIR data, the largest peaks for calcined egg shells were found at wave numbers $3339.69470\text{ cm}^{-1}$, indicating the existence of hydroxyl groups with O-H stretch. The peak at wavenumber 1640.0286 cm^{-1} indicates the presence of the C=C stretch, while the C≡C stretch with the presence of alkynes functional groups was observed at wavenumber $2117.12789\text{ cm}^{-1}$ (Alkenes).

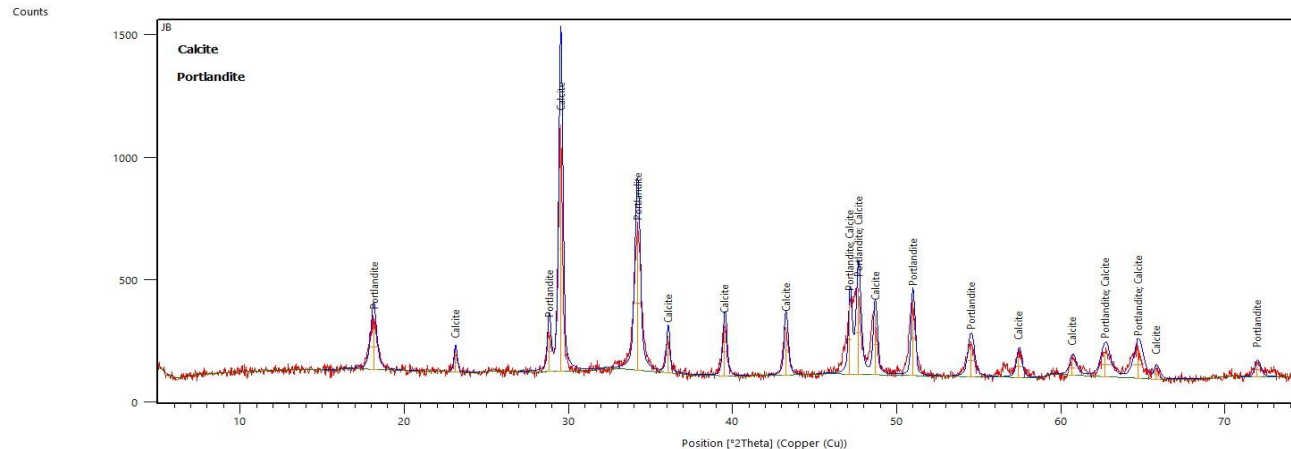


Results and Discussion

CHARACTERISATION OF THE PREPARED CATALYST

- **X-ray Diffraction (XRD)**

The XRD peaks labelled “portlandite” as shown in the graph below are attributed to $\text{Ca}(\text{OH})_2$ while the peaks labelled “calcite” are attributed to CaCO_3 . It can be concluded that the calcined eggshells is made of calcium hydroxide and calcium carbonate. The distinct peaks at 2 theta that correspond to the hexagonal layered crystal of portlandite, according to the plot, are 18° , 28.9° , 34° , 51° , 54.5° , and 72° . The extra 2 theta peaks at 23° , 29.5° , 36° , 39.5° , 43.2° , 48.9° , 57.3° , 60.5° , and 66° are hexagonal calcite crystals.



Results and Discussion

The effect of Temperature and Catalyst on Biodiesel yield

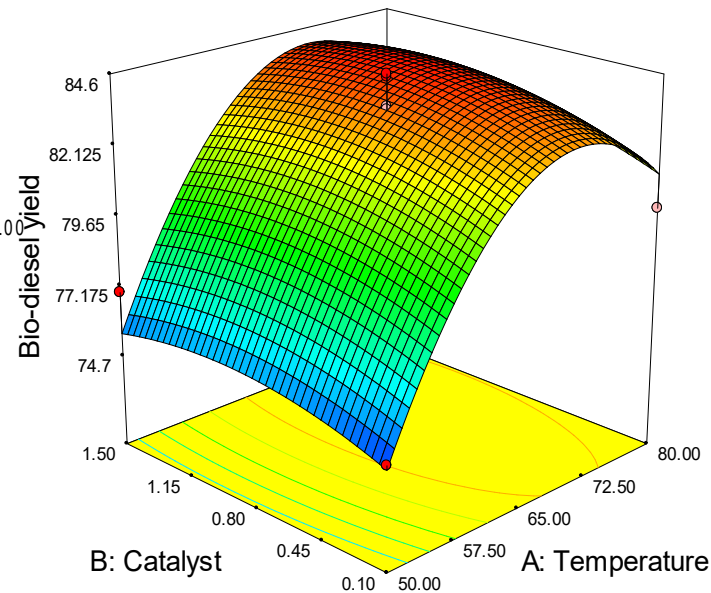
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Bio-diesel yield



X1 = A: Temperature
X2 = B: Catalyst

Actual Factors
C: Time = 90.00
D: Methanol/Oil ratio = 12.00



RSM 3D plot showing the effect of Temperature and Catalyst on Biodiesel yield while keeping other two parameters constant.

This 3D plot shows the effect of catalyst and temperature on biodiesel yield at constant time and methanol to oil ratio. At 0.1 weight% of catalyst, varying the temperature from 50 to 80°C, there was an increase in the biodiesel yield. At 50°C moving from 0.1 to 1.5 weight% catalyst, there was less effect on the biodiesel yield compared to temperature.

Results and Discussion

The effect of Temperature and Time on Biodiesel yield

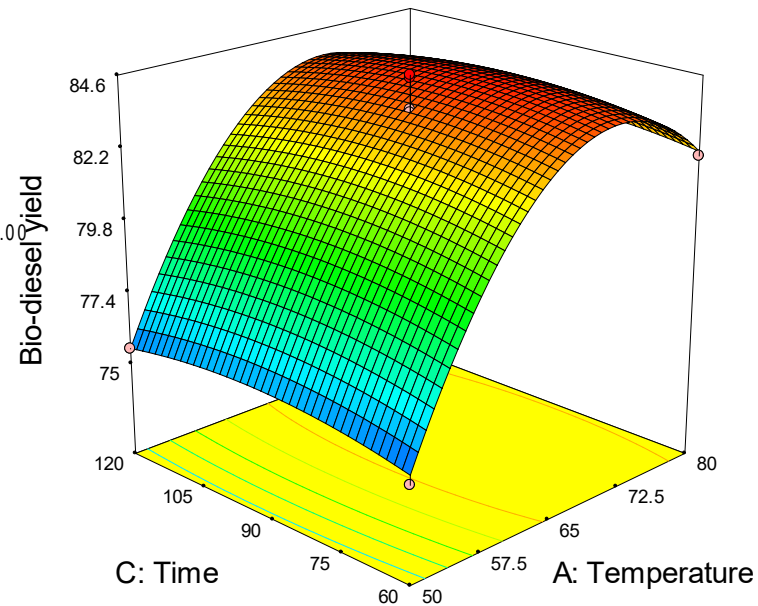
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Bio-diesel yield



X1 = A: Temperature
X2 = C: Time

Actual Factors
B: Catalyst = 0.80
D: Methanol/Oil ratio = 12.00



RSM 3D plot showing the effect of Temperature and Time on Biodiesel yield while keeping other two parameters constant.

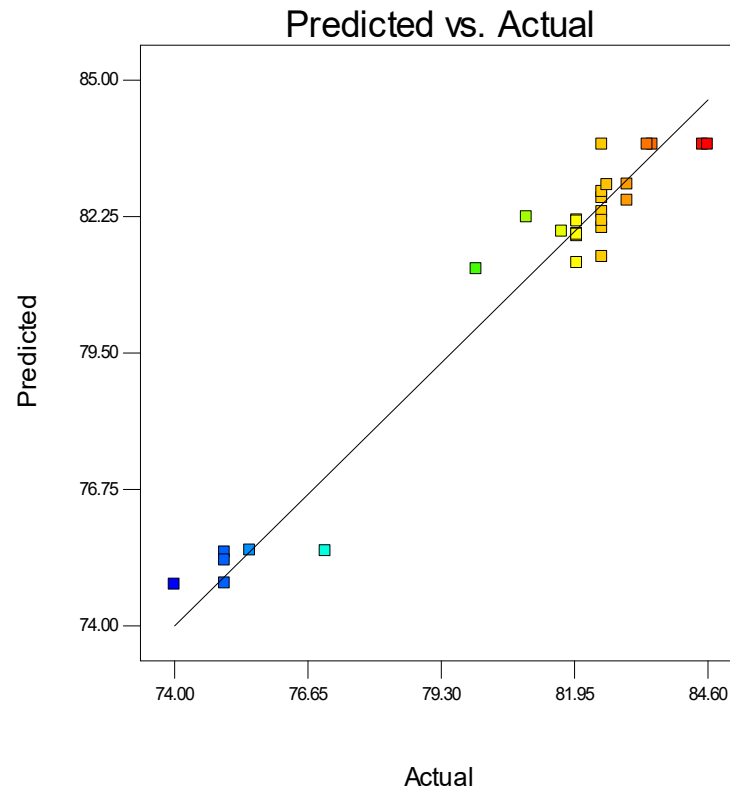
This 3D plot shows the effect of time and temperature on biodiesel yield at constant catalyst and methanol to oil ratio. At time of 60mins, varying the temperature from 50 to 80°C, there was an increase in the biodiesel yield. At 50°C moving from 60 to 120 mins, there was less effect on the biodiesel yield compared to temperature.

Results and Discussion

THE PREDICTED VS ACTUAL PLOT OF BIODIESEL YIELD

Design-Expert® Software
Bio-diesel yield

Color points by value of
Bio-diesel yield:



The projected and experimental values of the produced biodiesel yield are shown in Figure 4.13 and the R^2 found (0.9573) indicates a strong correlation between the collected data. This demonstrates how well the model captured the true link between the factors that were chosen.



Conclusions and Recommendations

CONCLUSION

Using egg shells as a catalyst to produce biodiesel from rubber seed oil, the created models were successful in explaining the parametric influence of the operating variables taken into consideration. The R^2 value discovered (0.9573) shows a significant connection between the data gathered. This illustrates how effectively the model caught the real relationship between the parameters that were selected.

RECOMMENDATION

In this study, rubber seed oil was simultaneously esterified and trans-esterified in order to produce biodiesel fuel utilizing a heterogenous catalyst made from egg shell. The following topics need to be looked at in order to better comprehend this research: Investigating how temperature affects the calcination of egg shell, The investigation of the impact of catalyst impregnation ratios, Investigating the reaction's kinetics, Investigating the impact of the catalyst's regeneration and reusability



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Thank You