

SYNTHESIS CHARACTERIZATION OF WASTE VEGETABLE AS BIOCATALYST IN BIODIESEL

Submitted in partial fulfillment of the requirements for the award of

**Bachelor of Engineering degree in
Mechanical Engineering**

By

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**DEPARTMENT OF MECHANICAL ENGINEERING
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SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade “A” by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600 119.

APRIL – 2023



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DEPARTMENT OF MECHANICAL ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **KAIPA SAI VISHNU CHARAN (39150061)** and **DADI AVANTH KUAMR (39150028)**, who carried out the project phase-1 entitled **"SYNTHESIS CHARACTERIZATION OF WASTE VEGETABLE AS BIOCATALYST IN BIODIESEL"**. Under our supervision from December 2022 to April 2023.

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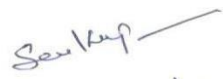
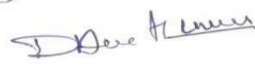
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DECLARATION

We **KAIPA SAI VISHNU CHARAN (39150061)** and **DADI AVANTH KUAMR (39150028)**, hereby declare that the Project report entitled **“SYNTHESIS CHARACTERIZATION OF WASTE VEGETABLE AS BIOCATALYST IN BIODIESEL”** Done by me under the guidance of **Dr.J.HEMANANDH, M.E., Ph.D.**, is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree In Mechanical Engineering.

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DATE :26.04.2023

PLACE: CHENNAI

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ABSTRACT

The vegetable wastes produced globally provide a new source of biomolecules. These biomolecules are efficiently used for the synthesis of nanoparticles or vegetable wastes acted as nanofactories. The main advantages of nanoparticles synthesized using vegetable waste are highly biocompatible, insignificant toxicity, high reactivity, and high stability with that of the traditional process that enhances the effectiveness of the nanoparticles toward the end application. The catalyst is prepared with the process of hydrothermal synthesis process and the catalyst is used in the production of biodiesel with raw oil. The controlled morphology of the nanoparticles with the help of different vegetable peels.

CHAPTER 1

INTRODUCTION

Nanomaterials provide numerous areas of research and their applicability towards a wide range of applications due to their extraordinary characteristics and crystallization properties. Nanoparticles are used in the production of biodiesel as a catalyst and can increase the reaction rate of the reaction. Usually, the synthesis of nanoparticles depends on the temperature and pressure. The shape and size of the nanomaterials might be easily tuned with the temperature of the reactions. Through this process, the catalysts are prepared and used for the production of biodiesel. Moreover, these vegetable wastes accumulate on soil or improper management leads to water, soil and air pollution. However, minimization or biodegradation and management of the fruits and vegetable waste remain concerns. Therefore, there is a need to be developed eco-friendly technologies. Esterification and transesterification will be done to produce biodiesel from raw oil.

1.1 HYDROTHERMAL SYNTHESIS

Hydrothermal synthesis is one of the most commonly used methods for preparation of nanomaterials. It is basically a solution reaction-based approach. In hydrothermal synthesis, the formation of nanomaterials can happen in a wide temperature range from room temperature to very high temperatures. To control the morphology of the materials to be prepared, either low-pressure or high-pressure conditions can be used depending on the vapor pressure of the main composition in the reaction. Many types of nanomaterials have been successfully synthesized by the use of this approach. There are significant advantages of hydrothermal synthesis method over others. Hydrothermal synthesis can generate nanomaterials which are not stable at elevated temperatures. Nanomaterials with high vapor pressures can be produced by the hydrothermal method with minimum loss of materials. The compositions of nanomaterials to be synthesized can be well controlled in hydrothermal synthesis through liquid phase or multiphase chemical

reactions. This special issue serves as a forum presenting the recent research results of hydrothermal synthesis of nanomaterials. Several papers on hydrothermal synthesis of nanoparticles, nanorods, nanotubes hollow nanospheres, and graphene nanosheets have been published in this special issue.

1.1.1 Temperature Difference Method

The majority of hydrothermal syntheses and crystal growths use this technique. The temperature inside the crystal growth region is reduced to achieve supersaturation. The aqueous solution (containing the solute) is kept at the bottom section of the autoclave. The heating of autoclave results in the creation of two zones of different temperatures. The solute particles dissolve in the hotter zone. The convective movement of the solution transfers the saturated aqueous solution from the lower part towards the upper part of the autoclave. As the saturated solution ascends, a counterflow of cooler and denser solution present in the upper part occurs. This counterflow of solution results in the descend of cooler and denser solution towards the lower end of the autoclave. As the temperature is decreased, the solution in the upper part supersaturates resulting in the onset of crystallization.

1.1.2 Temperature Reduction Technique

There is no temperature difference across the autoclave length. To achieve the supersaturation and thereafter, crystallization, the temperature of the solution present inside the autoclave is gradually reduced. However, the difficulties involved to control the growth process and introduce seed crystals are the major drawbacks of this technique due to which it is rarely employed.

1.2 CATALYST

A substance that increases the rate of a chemical reaction without itself undergoing any permanent chemical change.

1.2.1 Nanoparticles

Nanomaterial-based catalysts are usually heterogeneous catalysts broken up into metal nanoparticles in order to enhance the catalytic process. Metal nanoparticles have high surface area, which can increase catalytic activity. Nanoparticle catalysts can be easily separated and recycled.

1.2.2 Characteristics of Catalyst

Some of the important characteristic features of catalysts are, A catalyst does not initiate a chemical reaction. A catalyst does not be consumed in the reaction. Catalysts tend to react with reactants to form intermediates and at the same time facilitate the production of the final reaction product.

1.3 BIODIESEL

Biodiesel is an elective fuel like ordinary or 'fossil' diesel. Biodiesel can be delivered from straight vegetable oil, creature oil/fats, fat and waste cooking oil. The interaction used to change these oils over to Biodiesel is called transesterification. Most biodiesel delivered at present is created from squander vegetable oil sourced from cafés, chip shops, modern food makers, for example, Birdseye and so on However oil directly from the rural business addresses the best potential source it isn't being delivered industrially basically in light of the fact that the crude oil is excessively costly. After the expense of changing, it over to biodiesel has been added on it is just too costly to even consider rivaling fossil diesel.

To handle the contamination issue because of fossil fuel byproducts from autos, the most appropriate arrangement is utilizing the biofuels created from the food yields like jatropha, sunflower oil, rapeseed oil, cotton-seed oil and elastic seed oil in a proficient and affordable strategy. These days, the two significant difficulties to save the climate from an Earth-wide temperature boost are the green-house gases radiated to environment and the connected environmental change each year around the world. The arrangement

incorporates the estimating of the carbon impression, examination and decrease by improving energy proficiency and followed by moderating fossil fuel byproducts. The Department of Energy characterizes biodiesel follows:

“The biodiesel is a locally created sustainable fuel that can be fabricated from vegetable oils, creature fats, or reused café lubes. Biodiesel has various benefits over other elective energies because it has the fuel properties that of diesel fuel got from oil.

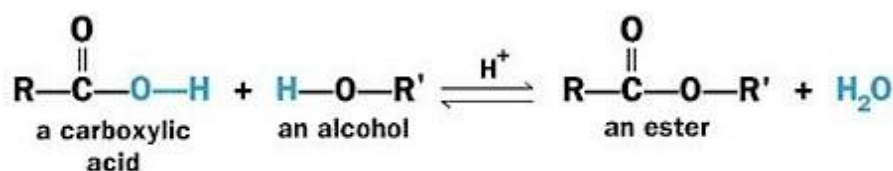
1.4 BIODIESEL PREPARATION

1.4.1 Esterification

Esterification is the process of combining an organic acid (RCOOH) with an alcohol (ROH) to form an ester (RCOOR) and water; or a chemical reaction resulting in the formation of at least one ester product. Ester is obtained by an esterification reaction of an alcohol and a carboxylic acid. (Or)The process of making biodiesel from free fatty acids by mixing with alcohol and using catalyst.

1.4.2 TRANSESTERIFICATION

Transesterification is an organic reaction in which the R group of an alcohol is exchanged with an R group of an ester. This is generally done via the introduction of an acid or base catalyst to the reaction mixture. However, it can also be done using certain enzyme catalysts (such as lipases). An illustration detailing the exchange of an R' group belonging to the alcohol with the R'' group of an ester in a transesterification reaction.



(Where R and R' are general hydrocarbon groups)

1.5 DIESEL ENGINES

Biodiesel raises the cetane number of the fuel and improves fuel lubricity. A higher cetane number means the engine is easier to start and reduces ignition delay. Diesel engines depend on the lubricity of the fuel to prevent moving parts from wearing prematurely.

CHAPTER 2

LITERATURE SURVEY

1. In 2022, Juliati Br. Tarigan [1], “Waste passion fruit peel as a heterogeneous catalyst for room temperature Biodiesel Production”, produced a highly active catalyst from the passion fruit peel and production of biodiesel from palm oil.
2. In 2021, Rishabh Anand Omar [1], “Vegetable waste for the biosynthesis of various nanoparticles”, The formation of biosynthesized nanoparticles depends on the pH, temperature, and nature of vegetable extract.
3. In 2021, Sebusi Odisitse[1], “ Comparison of CaO-NPs and chicken Eggshell-Derived CaO in the production of Biodiesel from schinziophyton rautanenii (mongongo) Nut Oil”, Biodiesel produced by transesterification from mongongo oil and saponification value, acid value, free fatty acid and density, the viscosity of the oil.
4. In 2021, Haris Mahmood Khan [1], “Application of Agricultural Waste as Heterogeneous Catalysts for Biodiesel Production”, preparation of heterogeneous catalysts, agriculture wastage into valuables and Biodiesel production via heterogeneous catalyzed technology.
5. In 2021, Andres Sarrion [1], “Fate of nutrient during hydrothermal treatment of food waste”, Hydrothermal carbonization was evaluated as a food waste valorization strategy to obtain hydrochar and recover nutrients.
6. In 2021, Yathish K.V [1], “ Biodiesel From Custard Apple Seed Oil And Its Characteristics Study”, Experimental methods and production of biodiesel from the custard apple oil.

7. In 2021, Raffel Dharma Patria [1], “ Hydroxyapatite-based catalysts derived from food waste digestate for efficient glucose isomerization to fructose” , converting the biomass waste into cost-effective catalysts for chemical reaction.
8. In 2020, Prashanth Kumar [1], “ Temperature selectively for single phase hydrothermal synthesis of PEG-400 coated magnetite nanoparticles” , Investigated on hydrothermal synthesis of magnetic particles.
9. In 2019, C.R. Girish [1], “ Catalyst preparation from various Naturally available Waste Materials for Biodiesel Production” types of catalysts used for transesterification reactions various types of catalysts.
10. In 2019, Giancarlo Chiatta [1], in “Effect of Waste Cooking Oil Biodiesel Blends on Performance and Emissions from a CRDI Diesel Engine”, investigated the preparation of Biodiesel from waste cooking oil and performance test and characterizations of the Biodiesel.
11. In 2017, Dragos Tutunea[1] , “ Analysis of performance and emissions of diesel of diesel engine using sunflower biodiesel”, emission test of diesel engine with sunflower biodiesel and the physical and chemical properties of blends of diesel.
12. In 2017, Rohan Gokhale [1], “ Hydrothermal synthesis of platinum group metal-free catalysts: structural elucidation and oxygen reduction catalysis” , experimented a novel hydrothermal approach to generate a platinum catalyst for oxygen reduction reaction.
13. In 2016, Fahad Ahmed [1], “Production of Biodiesel from Jatropha Curcas Seed Oil using Base Catalysed Transesterification”, synthesis of biodiesel from jathropha oil with the catalyst potassium hydroxide.

14. In 2016 , Eriola Betiku[1], “ Banana peels as a biobase catalyst for fatty acid methyl esters production using Napoleon’s plume seed oil:A process parameters optimization study” , catalyst is prepared with the banana peels and also the fatty acid methyl esters.
15. In 2016, Jianlin Lia [1], ”Synthesis of Nanoparticles via solvothermal Hydrothermal Methods” ,summarizes the synthesis of various types of nanoparticles as well as surface modifications of nanomaterials using hydrothermal and solvothermal methods.
16. In 2015,Omkaresh.B.R [1],”Biodiesel production from custard apple seed oil and its performance test on ci engine”, focused on discovering the fuel that would be adaptable to the existing engine constructions and that would meet the criteria regarding renewability, ecology and reliability of use.
17. In 2015, Siddalingappa R.Hotti [1], ”Biodiesel production process optimization from sugar apple seed oil and its characterization”, the process parameters such as catalyst concentration, reaction time, and reaction temperature were optimized for the production of sugar apple biodiesel.
18. In 2014,Amir Khalida [1],”Effects Of Biodiesel On Performance And Emissions Characteristics In Diesel Engine”, to investigate the effects of oil palm, engine speed test, load conditions and engine performance.
19. In 2014, Hugo A. Lara-García[1]”Hierarchical Na-doped cubic ZrO₂ Synthesis by a simple hydrothermal route and its application In biodiesel production”, different nano-crystalline ZrO₂ Samples were successfully synthesized via a simple hydrothermal method in the presence of various surfactants and sodium hydroxide.

20. In 2013, Mohammed EL Kassaby [1], "Studying the effect of comparison ratio on and engine fuelled with waste oil produced biodiesel fuel", the effect of blending ratio and compression ration on a diesel engine performance has been investigated. Emission and combustion characteristics was studied when the engine operated using the different blends (B10,B20,B30,and B50) and normal diesel fuel(B0) as well as when varying the compression ratio from 14 to 16 to 18.

CHAPTER 3

AIM AND SCOPE OF WORK

3.1 AIM

Preparation of catalyst from waste vegetable peels and characterization of nanoparticles. Production of biodiesel using the catalyst and advancing the performance of biodiesel using a diesel engine.

3.2 SCOPE OF WORK

To alter the compression ratio, injection timing, and injection phase in Engine with biodiesel. In the future, we will use it as a major energy source and we can run vehicles with these biodiesels. To overcome hazardous pollution with the usage of biodiesel.

CHAPTER 4

MATERIALS AND METHODS

4.1 MATERIALS

- Autoclave
- Stainless steel shell
- Stainless steel lid
- Beaker
- Vegetable peels
- Thermometer
- Viscosity
- Nitrogen gas
- Water solvent
- Conical Funnel
- Teflon cup

4.2 METHODS

4.2.1 Hydrothermal process

Hydrothermal processing is usually performed in a steel pressure vessel also defined as autoclave wherein the processing conditions are controlled by adjusting the temperatures and/or pressures. The autoclave may or may not be coated with protective Teflon coatings. The processing is carried out in aqueous solution. Temperature is increased beyond boiling temperature of water, attaining the pressure of vapour saturation. Internal pressure depends largely on temperature and the quantity of solution put in the reaction chamber (autoclave). This procedure is extensively used for producing small particles in ceramics industry.

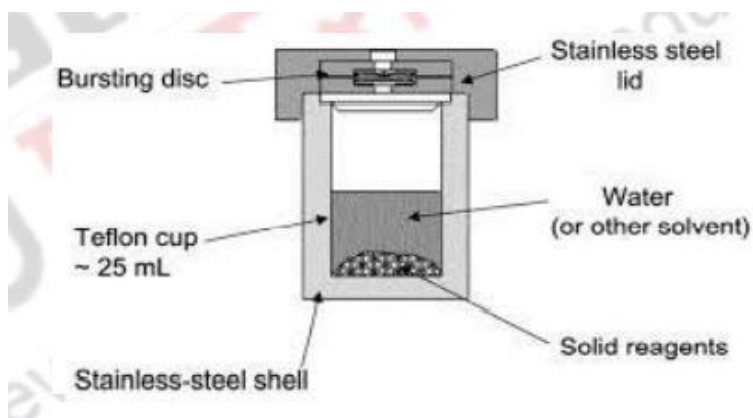
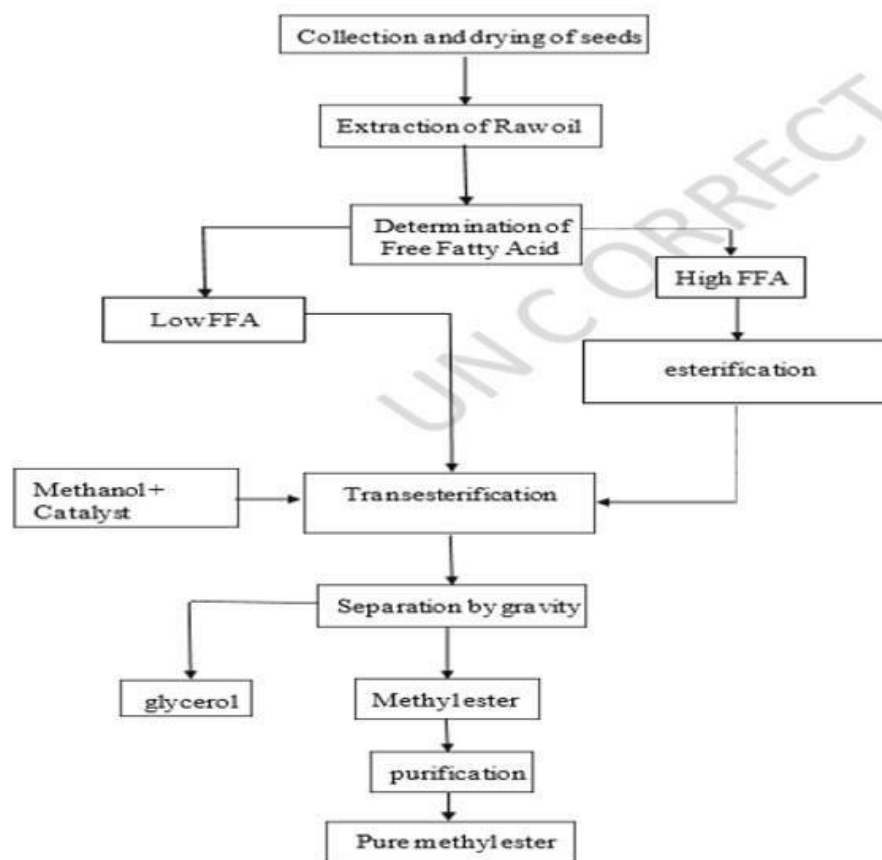


Figure 2 Schematic of a hydrothermal experiment setup.

The impact of these variables poses problems which are not yet satisfactorily resolved. Temperature controls the formation kinetics and thermodynamic stability of products. Pressure influences solubility, supersaturation range stipulating crystallization process and also the thermodynamic stability of the products (higher pressure $\rightarrow$ denser phases).

4.2.2 Transesterification Process

Transesterification is an organic reaction in which the R group of an alcohol is exchanged with an R' group of an ester. This is generally done via the introduction of an acid or base catalyst to the reaction mixture. However, it can also be done using certain enzyme catalysts (such as lipases)



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