Print ISSN: 0974-2115
www.jchps.com Journal of Chemical and Pharmaceutical Sciences

Studies on Eco-friendly Production of Biodiesel from Marine Seaweed

Annam Renita A*, Azmin Hannan, Prayashi Phukan
Department of Chemical Engineering, Sathyabama University, Chennai-119.
***Corresponding author: E-Mail: reniriana@gmail.com**

ABSTRACT

In this research paper, a marine seaweed, *Cauler papelata* obtained from Gulf of Mannar was investigated for bio-diesel production. Biodiesel was prepared from *Cauler papelata* and its fuel properties were analyzed according to ASTM D6751 standards. Algal oil was extracted by solvent extraction using chloroform/methanol system. The extracted algal oil was further transesterified using methanol and catalyst. Various catalyst systems comprising of commercial catalysts were compared with prepared eggshell catalyst. The eggshell catalyst was prepared by calcination of waste eggshells at various temperatures for various time periods. It was found that biodiesel produced using eggshell catalyst had the same performance compared to that of commercial catalyst. Moreover, the process produces an environmental friendly biodiesel which is sustainable and cost effective.

KEY WORDS: green biodiesel, *Caulerpa pelata,* catalyst, waste eggshells, environment.

1. INTRODUCTION

The scope of marine macro algae has a wide potential to behave as a raw material for bio-fuel production. As a resource of energy feedstock with high potential these macro algae are estimated to exceed the other biomass that are available terrestrially by three fold. This research paper focuses on the environmental friendly production of bio diesel from marine seaweed with the help of catalyst. But the commercial catalysts used for transesterification reaction have hazardous effects on the environment when their effluents are discharged into the environment. Oxides of magnesium and calcium oxide have been tried as solid base catalyst owing to their easy availability, low cost and non-corrosive nature. Research was also reported on the good performance of egg shells among the waste selection in transesterification as chicken egg shell contains the highest calcium and larger surface area as compared to golden apple snail and Meretrix venus shell. Research was done on used egg shells to undergo calcination–hydration–dehydration treatment to obtain CaO catalyst. Catalyst made from waste eggshells were compared for their efficiency with commercially available homogeneous and heterogeneous base catalyst and it was reported that eggshell catalyst gave a good yield in comparison to its competitors. Thereby a research study was made on a renewable catalyst from waste eggshells that could be used for biodiesel production from *Caulerpa pelata* so that the product could be termed as green biodiesel.

2. MATERIALS AND METHODS

Caulerpa peltata, a green seaweed was collected from Gulf of Mannar, Rameshwaram, India. The collected seaweeds were first washed with sea water and then it was washed with distilled water. The cleaned green seaweed were next dried and the final drying was done in an oven at a temperature of 60 ºC for 24 hours of duration. The seaweeds were then ground into a consistency of fine powder with the help of a mortar and pestle. The dried algae powder was then used to extract the oil using the method of solvent extraction. The solvents that were used are hexane and ether with a measurement of the solvent in the ratio of 1:1. Filtration of the oil was done and the sample was collected and weighed.

Sodium hydroxide and Potassium hydroxide were obtained from S.D. Fine chemicals. Waste eggshells were collected from canteen and bakery from Sholinganallur, Chennai in order to make a eggshell catalyst. For the cleaning process, the procured eggshells were initially washed with deionized water in order to remove the impurities that are present in the the shells. The eggshells were then dried at a temperature range of 100º C for a time period of 24 hours. After the drying process, at a high temperature ranging from 700-1000 degree celsius the egg shells were being calcined for three sets of time period. They are 2, 3 and 4 hours .The eggshells were characterized using Scanning Electron microscope to study the pore structure. Algal oil catalysed by sodium hydroxide is categorized as S1. Algal oil catalysed by potassium hydroxide is categorized as S2. Algal oil catalysed by prepared eggshell catalyst is categorized as S3. The preparation of biodiesel was done as per the procedure stated in the literature. As soon as the shaking process got over, the solution was allowed to settle by keeping it undisturbed for a time duration of 15hr. The different layers of bio-diesel, glycerol, foam and sediment got differentiated clearly in the settling flask. Each of the layers formed were carefully separated and the bio-diesel was collected separately in a container which was measured. The bio-diesel was washed by 5% water until it becomes clean of foam. Bio-Diesel was dried by using dryer and finally kept under running fan for 12hr. The bio-diesel obtained was measured and stored in a dried container for further analysis. All experiments were triplicated and their reproducibility was ± 5 %. The fuel properties were tested according to ASTM D6751 standards.

3. RESULTS AND DISCUSSION

The large size of vegetable oil molecules (typically three or more times larger than hydrocarbon fuel molecules) and the presence of oxygen in the molecules suggest that some fuel properties of vegetable oil would differ markedly from those of hydrocarbon fuels. The conversion of triglycerides into methyl or ethyl esters through the transesterification process, reduces the molecular weight to one-third that of the triglyceride and also reduces the viscosity by a factor of about eight and increases the volatility marginally

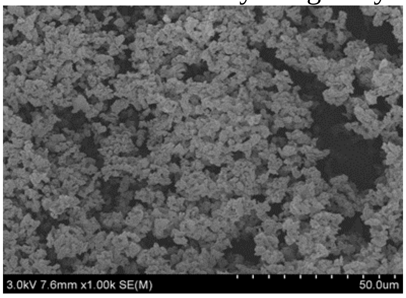

Figure.1. SEM image of eggshell catalyst

Figure.1, represents the porous structure of prepared eggshell catalyst with an average pore size of 77.2 nm measured using 500 micrometer resolution. It exhibits a highly porous structure distributed in a random manner.

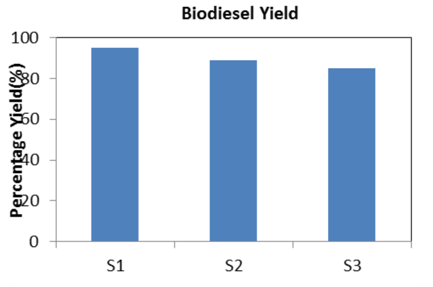

Figure.2. Biodiesel yield

A comparison study of the various catalysts was made in order to find the differences in the yield percentage of the biodiesel for each of the catalysis process. From figure.2, we could obtain that the percentage yield of algal oil was the highest when sodium hydroxide was used as the catalyst. (S1)

The yield percentage obtained when potassium hydroxide was used as the catalyst was lesser compared to sodium hydroxide (S2) which was followed by the yield percentage obtained when egg shell catalysts were being used (S3).

Table.1. Comparison of fuel properties

Property	S1	S2	S3	ASTM D6751
Acid Value (mgKOH/g)	0.22	0.3	0.19	0.5
Kinematic Viscosity (CSt)	3.2	2.9	3.1	2.5-6
Flash point (°C)	100	100	110	min 100
Calorific Value (KJ/Kg)	32.1	33.5	32.7	50

The acid number is a measure of the amount of carboxylic acid groups present in a chemical compound, example fatty acid value of fuel, also known as neutralization number is the amount of potassium hydroxide (in mg) which is required to neutralize 1 gm of any chemical substance. For biodiesel the acid number should be lesser than 0.50 mgKOH/g in order to avoid corrosion. The free fatty acid produced may have the tendency to corrode the automotive parts of the vehicles and this would in turn limit the protection of the engine and fuel tanks. For all the three cases of transesterification of algal oil using the catalysts that are sodium hydroxide, potassium hydroxide and the eggshell catalyst it was found that the acid value of the biodiesel is within the limit. Kinematic viscosity is a major property of all the fuels. There is a negative impact on fuel injection system performance if the kinematic viscosity has a higher range of value. Also the higher value of kinematic viscosity results in incomplete combustion, poor atomization of fuel, coking of the fuel injectors and ring carbonization of the fuel. The kinematic viscosity of algal oil produced using S1, S2 and S3 catalysts is within the limits provided by the ASTM D6751 standards. Flash point of a fuel is the lowest temperature at which the fuel ignites when exposed to a spark. According to ASTM standards the flash point should be of minimum 100 and the flash point of the algal oil produced is within the limits. The calorific value of a fuel is the amount of energy that can be determined by measuring heat produced when the complete combustion of a specified amount of the fuel. The calorific value as per ASTM standards is of 50. The calorific value of the algal oil for all the three cases is within the limits.

4. CONCLUSION

The present research work deals with the production of green fuel by substituting the raw materials for biodiesel preparation with degradable materials. A catalyst made from waste eggshells which is a renewable and green catalyst was used for biodiesel production from marine macroalgae *Caulerpa peltata.* The eggshells were calcined to prepare a porous catalyst with average pore size of 77.2 nm. It was compared with commercial catalysts like sodium hydroxide and potassium hydroxide. The yield from the green catalyst was comparable with commercial catalysts. Fuel properties like acid value, kinematic viscosity, calorific value and flash point of prepared green diesel was within the limits prescribed by ASTM D6751. Hence it can be concluded that waste eggshells can be used as an effective catalyst for biodiesel production from seaweeds.

REFERENCES

Annam Renita A and Joshua Amarnath D, *Caulerpa peltata* Methyl Esters as a Renewable Source of Energy Asian Journal of Chemistry, 24 (8), 2012, 3653-3655.

Annam Renita A, Sai Bhargav S, Prince Kumar Evaluation of fuel properties of various biodiesel generation feedstocks International Journal of Applied Engineering Research, 2013, 1865-1869.

Annam Renita, Pooja Paul Chowdhury, Parveen Sultana, Prayashi Phukan, Azmin Hannan Utilization of waste eggshells for production of renewable catalyst for transesterification International Journal of Pharmacy and Pharmaceutical Sciences, 8 (7), 2016, 1-4.

Goering C.E, Schwab A.W, Daugherty M.J, Pryde E.H, Heakin A.J, Fuel properties of eleven vegetable oils, Transactions of the SAE, 25 (6), 1982, 1472 - 1483.

Niju S, Meera S, Begum KM, Anantharaman N, Modification of egg shell and its Application in biodiesel production, J Saudi Chem Soc, 5, 2014, 702–706.

Singh SP, Dipti Singh, Renewable and Sustainable Energy Reviews, 14, 2010, 200–216.

Viriya-empikul N, Krasae P, Puttasawat B, Yoosuk B, Chollacoop N, Faungnawakij K, Waste shells of mollusk and egg as biodiesel production catalysts, Bioresour Technol, 101, 2010, 3765–3767.

Yogesh Sharma C, Bhaskar Singh, John Korstad, Latest developments on application of heterogeneous basic catalyst for an efficient and eco-friendly synthesis of biodiesel, A review, Fuel, 90, 2011, 1309-1324.