Comparison Studies of Bio-Diesel Production from Seed Oils Through a Sustainable Catalyst

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Abstract

Increase in demand for energy production and its supply, rise in petroleum prices, environmental issues have lead in search of new alternative energy resources. This eventually lead in using edible oils as essential feed stock but in recent years, the food verses fuel controversy made edible oil a non-ideal feed stock. In search for alternative non-edible feed stocks, GuizotiaAbyssinica and CucumisSativus seed oils were found to be potential feed stocks for the synthesis of Bio-Diesel through transesterification process using Crystalline Manganese Carbonate as catalyst. Crystalline Manganese Carbonate was found to be a sustainable catalyst since higher yields were obtained at 1 wt% catalyst for both the oils. The catalyst is pure, crystalline and ash colored in nature. It is a heterogeneous catalyst and promotes reuse of the catalyst for all most seven successive runs. It is a low cost and easily available, non-corrosive, versatile, environmental friendly, green and sustainable catalyst for the transesterification of non-edible feed stocks. In the present study, a comparison on effects of parameters like methanol quantity, catalyst amount, reaction time and reaction temperature for GuizotiaAbyssinica and CucumisSativus seed and Edible oils are done. The results show that using the catalyst CrystallineManganese Carbonate gives higher yields and conversions. The catalyst is neither corrosive nor emulsion forming and is easier to separate. The research focuses on sustainable catalyst and feed stocks that are economic and environmental friendly

Keywords: *GuizotiaAbyssinica, CucumisSativus, Edibleoils, Manganese Carbonate, Transesterification, Bio-diesel*

1. Introduction

As petroleum reserves are decreasing and demand for energy production is increasing, Bio-diesel is becoming a promising alternative fuel resource. Various attempts are being made on the new feed stocks and catalysts, for the production of bio-diesel [1-5]. Bio-diesel synthesis uses solid catalysts which have cheaper production cost and can be reused [6]. Bio-diesel is chiefly produced by transesterification process where triglycerides of oils in the presence of alcohol and catalyst yield biodiesel. In USA and Europe, Soybean and Rapeseed are common feedstock for bio-diesel production whereas Palm is the feedstock in South Asia [7-10]. The above mentioned Soybean, Rapeseed and Palm are the edible oil feedstocks and use of these edible oils for the production of bio-diesel may lead to inflationary pressures in vegetable oil market [11-14]. Therefore, attempts are being made in discovering non-edible feedstocks for the production of bio-diesel.

In the present work, Guizotiaabyssinica and Cucumissativus seed and various Edible oils are taken and compared for bio-diesel yields.

2. Materials and Methods

2.1. Materials:

Guizotia Abyssinica seeds are collected from Araku, Vizag, Andhra Pradesh, Orissa and Karnataka, India Cucumissativus seed oil, Crystalline Manganese carbonate and Methanol are purchased directly from the laboratories.

Analysis of Guizotia Abyssinica and CucumisSativus oils:

Guizotia Abyssinica and Cucumis sativa seed oil (cucumber oil) are subjected to Gas chromatography to determine the composition. The samples are analyzed for their fatty acid content. Table1 and Table2 give the fatty acid composition of the two oils.

Table1: Fatty Acid Composition of Guizotia Abyssinica oil

Fatty acids	Percentage (%) Composition
Palmitic (C16/0)	9.2
Stearic (C18/0)	10.1
Oleic (C18/1)	9.0
Linoleic (C18/2)	71.7

Reuse and recovery of Catalyst:

In the present work, the manganese carbonate catalyst is recovered by filtration and washed with 80°C distilled water 4-5 times. Then the catalyst is dried at 50°C for 35 hours in the hot air oven. After the complete drying the catalyst is used in the transestrification reaction. The efficiency of the catalyst is 95%. The catalyst is still efficient even after seven successive runs.

Experimental Procedure:

The materials are taken in the reaction flask and heated to a desired temperature. The mixture of catalyst in methanol with different concentrations is used for the conversion of Cucumis Sativa seed oil and GuizotiaAbyssinica seed oil to FAME. Transesterification reactions are performed in a 150 ml round bottom flask with a reflux condenser, stirring is provided by a magnetic stirrer. The stirrer is set at a constant speed throughout the experiments. The methanol and catalyst mixture are added to the round bottom flask containing oil. At that point, the reactions are kept under reflux conditions. The formation of methyl esters from the oils are monitored by thin layer chromatography. The methyl esters are washed with distilled water and concentrated under vacuum to afford FAME.

3. Results and Discussion

Effect of methanol to oil ratio:

Methanol to oil ratio is one of the most important variables in methyl ester production. Fig.1 shows, 1:1 methanol to oil ratio gives highest biodiesel yield for Cucumis Sativus seed oil whereas 5:1 methanol to oil ratio gives highest biodiesel yield for Guizotia Abyssinica seed oil.

Table2: Fatty Acid Composition of CucumisSativus oil:

Fatty acids	Cucumber oil %
Palmitic(C16/0)	11
Stearic(C18/0)	7
Oleic(C18/1)	14
Linoleic(C18/2)	68

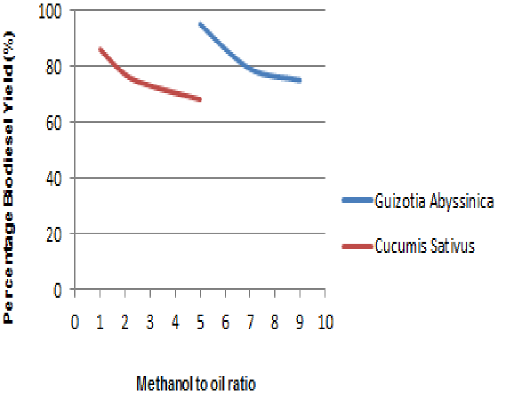

Figure.1: Effect of methanol to oil ratio

Effect of Catalyst quantity:

Fig.2 Shows at 1 wt% catalyst is observed with higher yields. It is obtained 95% of biodiesel yield from Guizotiaabyssinica seed oil and 86% of biodiesel yield from Cucumis Sativa seed oil.

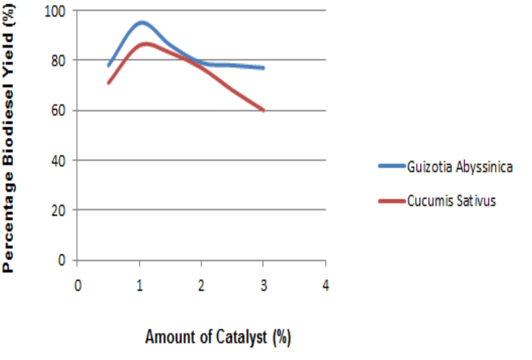

Figure.2: Effect of Catalyst quantity

Effect of Reaction Temperature:

As temperature increases, from Fig.3 it is observed that Biodiesel yield increases. Beyond 70^0C emulsification takes place which is not desirable.

Effect of Reaction time:

During the transesterification reaction, continuous stirring is provided at a constant rate. In Fig.4, the conversion of GuizotiaAbyssinica seed oil to Biodiesel yield of 95% was achieved in 180 min whereas for

CucumisSativus seed oil it took 180 min to achieve 86% yield.

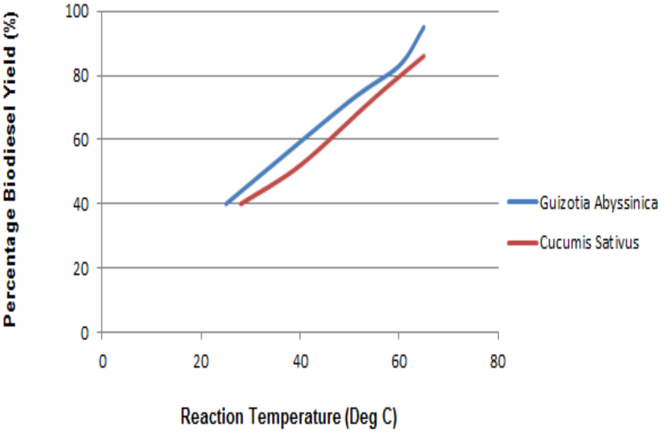

Figure.3: Effect of reaction temperature

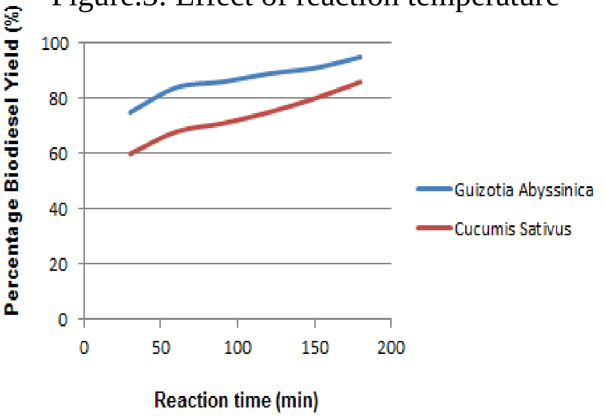

Figure.4: Effect of reaction time

Comparison with other Edible Oils:

Figures.5 compared with different Vegetable oils with the present study. It is concluded that Vegetable oils primarily contain trigycerides and their chemical structure is significantly different from that of mineral diesel. Transterification is an efficient method to convert high viscosity Vegetable oils into a fuel with chemical properties similar to those of mineral diesel. Consequently, Vegetable oil causes poor fuel atomization, incomplete combustion and carbon deposition on the injector and valve seats, resulting in serious engine fouling. [15] Different approaches have been considered to reduce the high viscosity of Vegetable oils. Biodiesel properties are strongly influenced by the properties of the individual fatty esters. [8] In searching for alternative method with Non-edible seed oils, Guizotia Abyssinica and CucumisSativus with Nanosized Mn (II) carbonate could be used as an efficient and selective catalyst.

The authors concluded that Guizotia Abyssinica and CucumisSativus Non-Edible seed oils are better than Edible oils and also to avoid the controversy of Food and Fuel.

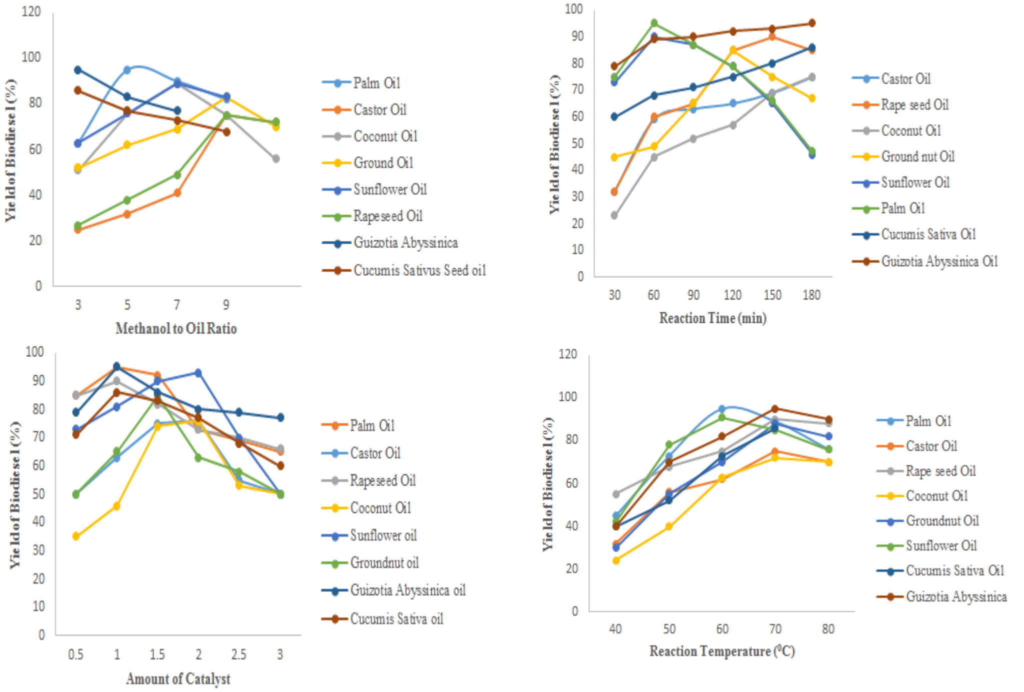

Figure.5: Effect of Methanol to Oil Ratio, reaction time, amount of catalyst and reaction temperature on yield of biodiesel

4. Conclusion

- The above graphs show that at 1:1 ratio of methanol to oil at 650C, catalyst weight of 1% gives the highest yield of 86% for CucumisSativus seed oil.
- At 5:1 ratio of methanol to oil at 650C, catalyst weight of 1% gives the highest yield of 95% for GuizoAbyssinica seed oil.
- It is observed that highest yields are obtained at 1 wt% catalyst for both the oils and the catalyst can be reused. Therefore, it can be concluded that Crystalline Manganese Carbonate as a sustainable, green catalyst.
- The authors concluded that Guizotia Abyssinica and CucumisSativus Non-Edible seed oils are better than Edible oils and also to avoid the controversy of Food and Fuel.

Acknowledgement:

The authors would like to thank the Principal, University College of Technology, Osmania University, Hyderabad, India for providing research facilities. The authors also want to acknowledge the President, Adama Science and Technology University and Dean, SOMCME, Department of Chemical Engineering, Adama, Ethiopia for providing Computer Facilities.

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