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Production of Bio-Diesel from *Cucumis Sativus* Seed oil involving Crystalline Manganese Carbonate – A Green (Nanosized) Catalyst

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Abstract

This paper focuses on the production of bio-diesel from low cost feed stock CucumisSativus seed oil using $MnCO_3$ as a Green (Nanosized) catalyst through transesterification process and investigating the effects of process parameters on bio-diesel yield. The optimum parameters for maximum bio-diesel yields were found to be methanol/oil molar ratio of 1:1, catalyst concentration of 1 wt% of oil, at the temperature of 65°C and reaction time 3 hours (180 min). The maximum bio-diesel yield at the optimum condition was 86%. Crystalline manganese carbonate was found to be environmentally friendly, easy to handle and non-corrosive green catalyst for the production of biodiesel from cucumber seed oil. The enhancement of the parameters are possible because of the Nano nature of the catalyst used. The results demonstrated high potential of producing economically viable biodiesel from low cost feed stocks with proper optimization of the process parameters.

Keywords: *Manganese Carbonate, CucumisSativus seed oil, Methanol, Transesterification, Bio-diesel.*

1. Introduction

Bio-diesel has been a promising alternate fuel during the past decade as a renewable source. It is a Biodegradable from transesterification of vegetables oil with alcohol has been accepted for use in blends with conventional petroleum fuel for transportation applications [1-4]. Soybean and Rapeseed are common feedstock for biodiesel production in USA and Europe respectively. Likewise, palm is being exploited in South East Asia [5]. In order to explore additional

oil resources (Non-Edible oils), the study on potential of Cucumber (Cucumis Sativus) seed oil as bio-diesel resource is reported here. The potentiality of Crystalline Manganese Carbonate as a catalyst has proven worthy for the bio-diesel yield. This was possible because of its Nano nature. Bio-diesel fuel is made from vegetable oils, animal fats, and microbial oil (algae, yeast, bacteria, and fungi).The most common method in the production of bio-diesel is the transesterification reaction, where the triglycerides present in oil react with monohydric alcohol in the presence of a catalyst, such as sodium hydroxide, sodium methoxide, potassium hydroxide, crystalline manganese carbonate and potassium methoxide [1-4, 6]. Bio-diesel synthesis using solid catalysts like Manganese Carbonate, instead of homogeneous catalysts like sodium hydroxide, could potentially lead to cheaper production costs by enabling reuse of the catalyst [7-13]. In the present study, attempt has been made to convert CucumisSativus seed oil to Fatty Acid Methyl Esters (FAME) using crystalline manganese carbonate a low cost, non-corrosive and green catalyst. This brings about 86% conversion of oil to FAME.

Transesterification (Fig 1) is the chemical reaction between triglycerides and alcohol in the presence of the catalyst to produce monoesters. The heterogeneous Manganese Carbonate base catalyst is active for high molecular weight alcohol achieving conversion to 90% and produces neither corrosion nor emulsion making it easier to separate the product obtained [2]. In literature, many attempts have been made for search of new effective catalysts and feed stocks using transesterification reaction, for the production of Bio-diesel. M. ArunKumari, et al. (2014) [1],

have concluded that Crystalline Manganese Carbonate gave higher yield than Zinc Oxide when producing bio-diesel from PongmiaPinnata and Guizotia Abyssinica feed stocks.

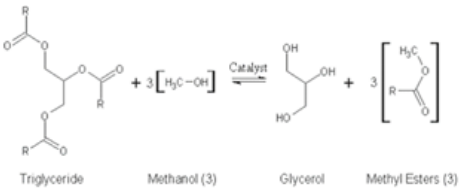

Fig.1.Transesterification of triglycerides with alcohol

2. Materials and Methods

2.1. Materials: The Cucumis Sativus seed oil, Crystalline Manganese Carbonate and methanol were purchased directly from the laboratories.

Analysis of Cucumber oil: Cucumis sativa seed oil (Cucumber oil) is subjected to Gas chromatography to determine the composition. The samples are analyzed with a Shimadzu GC-2010 gas chromatograph, equipped with a split less injection system. Helium is used as a carrier gas. Instrument conditions are maintained: column oven temperature 75°C, injection temperature 250°C, flow control mode in linear velocity with 92.5 cm/sec, total flow 61.2 ml/min, column flow 5.42 ml/ min, purge flow 1.5 ml/min, pressure 100 kpa, whereas the split ratio 10.0. Samples are prepared for analysis by adding approximately 0.05 gof oil phase to 5 ml of n-Hexane. About 1ml of this mixture is put in to the GC auto sampler vials. Two micro liters of the sample are injected into the column. The obtained results for fatty acid compositions of Cucumis Sativa seed oil (Cucumber oil) are shown in Table 1. Cucumis Sativa seed oil (cucumber oil) has the major fatty acids which are linoleic, stearic, oleic and palmitic acids.

2.2. Experimental Procedure:

The CucumisSativus seed oil (cucumber oil) is taken in the reaction flask and heated at 50°C. The mixture of catalyst in methanol with different concentrations is used for the conversion of

CucumisSativa 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. Initially, the oil was heated at a desired temperature. The methanol and catalyst mixture was added to the round bottom flask containing oil. At that point, the reaction is kept under reflux conditions. The formation of methyl esters from Cucumber oil is monitored by thin layer chromatography. The methyl esters are washed with distilled water and concentrated under vacuum to afford FAME.

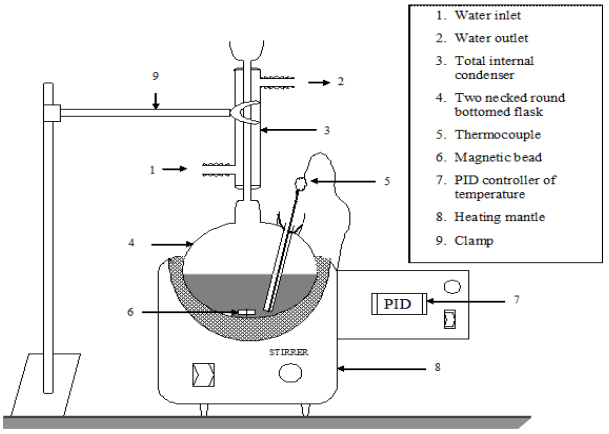

Fig.2. Schematic Diagram of the Experimental Setup

Catalyst analysis: In the present study, XRD and SEM analysis of Manganese Carbonate is Reported (Fig. 3 & 4).

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 shown in Table 2.

Table 1. Fatty acids CucumisSativa seed oil (Cucumber oil).

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

Table 2.The efficiency of the catalyst after seven successive runs

Catalyst Quantity 1%	Cucumis Sativa methyl esters yield (%)						
	First use	Second	Third	Fourth	Fifth	Sixth	Seventh
	95	95	94.5	94.5	94	94	93.5

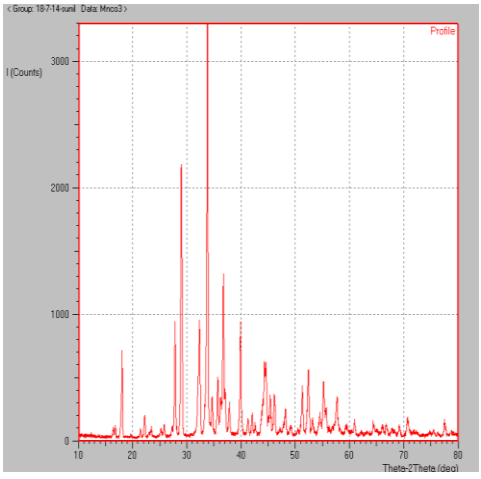

Figure.3: XRD of Manganese Carbonate.

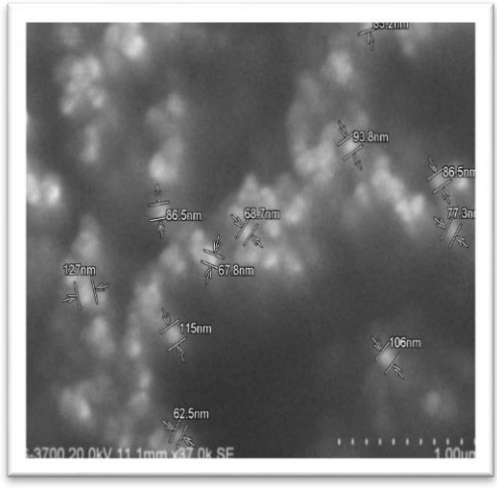

Figure 4:.SEM Image of Manganese Carbonate

3. Results and Discussion

Effect of methanol/oil molar ratio: In the present work, transe sterification of CucumisSativus oil with 1% $MnCO_3$ catalyst using alcohol /oil ratio between 1:1 and 5:1 is carried out; it is observed that the ester conversion increases

with the decrease in molar ratio up to the value of 1:1. The highest bio-diesel yield achieved at 1:1 molar ratio is 86% in 180 min. The results are depicted in Fig.5.

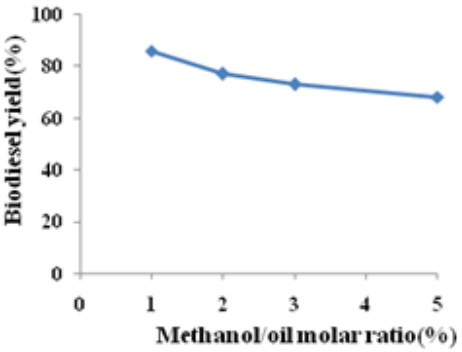

Fig.5. Effect of methanol/oil molar ratio

Effect of catalyst quantity: The highest bio-diesel yield 86% is obtained at 1wt% catalyst in 180 min. Further increases of catalyst quantity shows decrease in bio-diesel yield and add extra cost, since the catalyst needs to be removed from the reaction mixture after the reaction. The effects of $MnCO_3$ quantity on transe sterification are presented in Figure 6. At 1% of the catalyst the bio-diesel yield is 86%.

Effect of Temperature: The reaction temperature effect on the bio-diesel yield is studied in the range of 28-65°Cat atmospheric pressure. The maximum yield is achieved at 65°C 180 min. The methanol to oil molar ratio was 1:1 and the catalyst concentration is 1% in all the experiments. The temperature dependence of bio-diesel yield is presented on Fig.7.

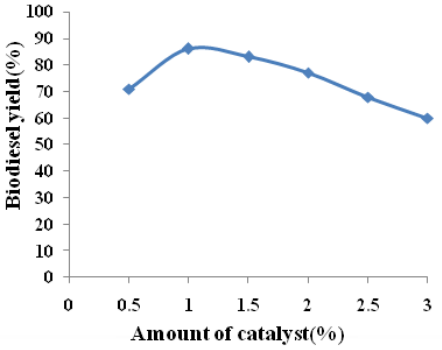

Fig.6. Effect of Catalyst quantity

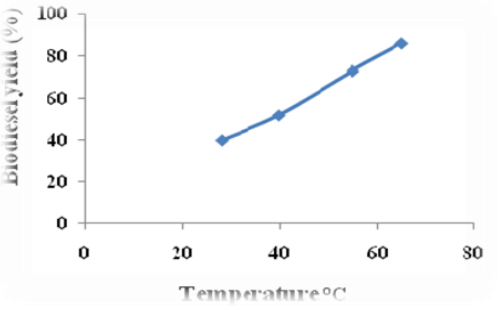

Fig.7. Effect of Reaction Temp.

Effect of Reaction time:

Experiments are carried out at various speeds between 30-180 min. The experiments showed that conversion of Cucumis Sativa oil to bio-diesel yield of 86% is achieved within 180 min at reflux condition. However, the reaction is carried out at the temperature close to the boiling point of methanol (60-70°C) at atmospheric pressure for a given time. The effect of reaction time on bio-diesel yield is reported in Fig.8.

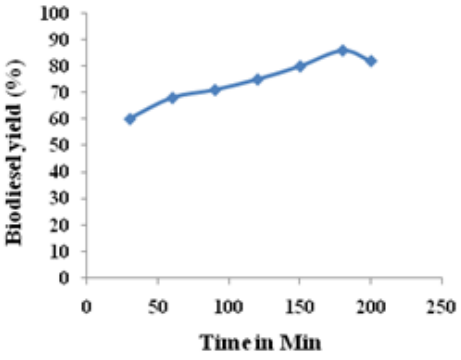

Fig.8. Effect of Reaction time

4. Conclusions

The studies on Crystalline Manganese Carbonate as a catalyst for bio-diesel production are cited in the Literature as a potential catalyst. But the reason behind the potentiality may be because of the Nano nature. The results show that at 1:1 ratio of methanol to CucumisSativusoil at 65°C gives the highest yield. The Bio-diesel yield conversion increases directly with decrease in methanol quantity at different catalyst to oil ratios. Using Manganese Carbonate (1% wt.) as the catalyst for Cucumis Sativus oil transesterification with methanol, 86% yield of bio-diesel is achieved. The Crystalline Manganese Carbonate (Nano sized) is found to be an alternative, green and heterogeneous catalyst for the production of Bio-diesel.

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References

[1] M ArunaKumari, K.S.K.Rao Patnaik, Y Rajeshwer Rao (2014), "Production of Bio-diesel from PongmiaPinnata and GuizotiaAbyssinica seed oil using Crystalline Manganese Carbonate (MnCO3) and Nano Zinc Oxide (ZnO) – A Green Catalyst", International Scientific Journal of Environmental Science, Vol. 3, pp. 14-20.

[2] Rajeshwer Y. Rao, Pudukulathan K. Zubaidha, Dasharath D. Kondhare, Narender J. Reddy, Sushma S. Deshmukh (2012), "Bio-diesel production from Argemone Mexicana seed oil using crystalline manganese carbonate", Polish Journal of Chemical Technology, 14, 1, pp. 65 -70.

[3] Yerraguntla Rajeshwer Rao, Pudukulathan Kader Zubaidha, Jakku Narender Reddy, Dasharath Dattatraya Kondhare, Deshmukh Shivagi Sushma (2012), "Crystalline Manganese Carbonate a Green catalyst for Bio-diesel Production", Green and Sustainable Chemistry, 2, pp.14-20.

[4] Y. Rajeshwer Rao, P. K. Zubaidha, J. Narender Reddy, D.D. Kondhare, S. Sushma Deshmukh, P.S. Santhoshi and Varala Ravi (2013), "Meloth riamaderaspatna seed oil: A low cost feedstock for Biodiesel production using crystalline manganese carbonate, a green catalyst", Journal of Petroleum Technology and Alternative Fuels, Vol. 4(5), pp. 94-98

[5] Rakesh Sarin, Meeta Sharma, Arif Ali Khan, (2009) "Studies on Guizotiaabyssinica L. oil: Bio-diesel synthesis and process optimization", Bio-resource Technology, 100, pp. 4187- 4192.

[6] Y. Rajeshwer Rao, P. S. Santhoshi, K.S.K. Rao Patnaik, J. Narender Reddy, Sandeep Bheemaji, K.C. Rajanna (2013), "Crystalline Manganese Carbonate a Low Cost and Green Catalyst for Bio-diesel Production from Jatropha Seed Oil", International Journal of Alternative Fuels, Vol. 15, Issue 2, pp. 1108-1113.

[7] S. Furuta, H. matsuhshi and K. Arata, (2004) "Bio-diesel Fuel production with Solid Superacid

Catalysis in Fixed Bed Reactor under atmospheric pressure", Catalysis Communication, Vol. 5, No. 12, pp. 721-723.

[8] K. Narsimharao, A. Lee and K. J. Wilson, (2007) "Catalyst in Production of Bio-diesel: A Review", Biobased Materials and Bioenergy, Vol. 1, No. 1, pp. 1-12.

[9] Xin Deng, Zhen Fang, Yun-hu Liu, Chang-Liu Yu (2011), "Production of bio-diesel from Jatropha oil catalyzed by nanosized solid basic catalyst", Energy, pp. 1-8.

[10] Mulatu Geleta, StenStymne, Tomas Bryngelsson, (2011) "Variation and inheritance of oil content and fatty acid composition in niger (Guizotia abyssinica)", Journal of Food Composition and Analysis 24, pp. 995-1003.

[11] Bashar Mudhaffar Abdullah, Rahimi M. Yusop, Jumat Salimon, Emad Yousif, Nadia Salih (2013), "Physical and Chemical properties analysis of Jatropha Curcas Seed Oil for Industrial applications", International Journal of Chemical Science and Engineering, Vol. 7, No. 12, pp. 183-186.

[12] Dipti Singh, S. P. Singh, (2010) "Low cost production of ester from non-edible oil of Argemone Mexicana", Biomass and Bioenergy 34, pp. 545-549.

[13] P. Pramanik, P. Das, P. J. Kim, (2012) "Preparation of biofuel from argemone seed oil by an alternative cost-effective technique", Fuel 91, pp. 81-8

