Research Article

Production of Biodiesel from *Jatropha curcas* by Using Homogenous Catalyst

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Abstract | Energy requirement, fuel prices, global warming, emission of green house gases and decrease the sources of fossil fuel are the major problems of these days. Due to increased population, urbanization and industrialization energy sources decrease gradually. Major portion of energy come from fossil fuel and to achieve the requirements of energy to find new source. Biodiesel is alternative renewable, biodegradable, non-toxic and eco-friendly of environment. *Jatropha curcas* is highly source to produce biodiesel which oil content up to 40 %. Normally trans-estrification process is used for biodiesel production. Main three types of catalyst were used for the production of biodiesel like as Heterogeneous, enzymes and homogenous. Process selection, catalyst, reaction time, Molar ratio are the main factor for biodiesel production. There are many nano catalyst used for biodiesel production with different yield 83.2 to 99. Pakistan 5% introduced blended biodiesel in 2015 and also increase 10% in 2025. Homogenous catalyst like as NaoH applied for the production of biodiesel from jatropha oil seed maximum recovery was 85%, reaction time 1 to 2 h at 65 °C temperature.

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1. Introduction

The massive quantity of petroleum products lead to increase the global warming and green house gases emission in the world (Indu *et al.*, 2020). The majority of researcher were working on environmental sustainability and energy crisis to find out new sources (Haris *et al.*, 2022). Presently the reduction of fossil fuel and climate change the researchers are trying to find alternative sources of energy (Krishna *et al.*, 2020). Biodiesel is a combination of fatty acid methy easter (Reddy *et al.*, 2016). It is renewable, biodegradable, environmental eco-friendly and non-toxic (Ranjitha *et al.*, 2019). It is produce from edible oils seed, non-edible oil, animal fats, waste cooking oil and algae (Verma *et al.*, 2016). Source of fatty acid can produce biodiesel (Rummi Devi Saini, 2017). Homogenous, heterogeneous and enzymes catalysts are used for the production of biodiesel. Strong acid and strong base are used as a catalyst in homogenous catalysis. The major of homogenous catalyst are destructive nature, incapable of recycling, non-eco-friendly and generate huge amount of effluent (Baskar and Ravi, 2015). Heterogeneous catalyst easy to separate,

regenerate, re-used and production cost reduced. Slowdown the reaction rate when used enzymatic catalyst and production cost increase (Gurunathan and Ravi, 2015). Adriana *et al*. (2022) studies about the production of Biodiesel from Jatropha seed plant at room temperature by using Potassium ferrate obtained yield 98%. The selection of raw materials for the production of biodiesel is around 70-95% and production cost can be reducing 60 to 70% by using low cost materials (Azocar *et al*., 2010).

Jatropha curcas is belong to Euphoribiacease family many years ago used for medicine treatment. It is non edible feed stock having high oil content up to 40% and can grows everywhere like as sand, gravelly or saline soil. The production of seed can be achieved in 12 to 15 month after cultivation 2 or 3 times in a year. Now a days many researchers are working to produce biodiesel from jatrpha seed to overcome on energy crisis for economical way. Therefore, it is expected in next few years 1 to 2 millions hectars jatropha plant planted in the world.

Cupper zinc oxide to use for biodiesel yield obtained was 97.7% (Sandhya *et al*., 2018). biodiesel yield, up to 73% in the first cycle and 64% in the second one by using CaO-ZnO catalyst having size average size of 2 µm (Javier *et al*., 2019). There are many nano catalyst used for biodiesel production with different yield 83.2 to 99 on different condition like that reaction time, molal ratio, feed stock and catalyst used (Mandana *et al*., 2014). maximum biodiesel yield of 97.71% by using CZO nanocomposite on these factor 12% (w/w) nanocatalyst concentration, 1:8 (v/v) O/M ratio, 55˚C temperature and 50 min of reaction time (Gurunathn and Ravi, 2015). 1.5 Zn/Mg-γAl2O3 used for castor oil to produce 99% yield (Marisa *et al*., 2020). ZnO/TiO_2 is a best conversion of biodiesel of soya bean oil (Mbala-Mukenga, 2012).

The different equipments are used to characterization of the catalysts some of them are Fourier-transform infrared spectroscopy, atomic force microscope, Scanning electron microscope, EDS, UV, ZETA POTIONAL, X-Ray diffraction and Nuclear magnetic resonance spectroscopy.

1.1 Composition of Jatropha oil

The composition of Jatropha oil was determined by gas chromatography which shows that composition of acid presented in oil sample. These acid values were representing in Table 1.

2. Materials and Methods

If the fatty acid valve is more than 2 the estrifaction process was used for the production of biodiesel, in this reaction sulfuric acid react with methanol which conveted free fatty acid to easter. A common method was used for the production of biodiesel from *Jatropha curcas* called transestrification, it is also called three steps method. The transesterification reaction was carried out with ratio v/v methanol-to-oil ratio, In transestrification reaction the triglyceride react with methanol,from this reaction to produce the triglyceride which converted to monoglycerides when further reaction with methanol. After that monoglycerides react with methanol to produce methyl ester and by product glycerine. Any material having easter is called Biodiesel. In the transestrification process these factors effecting on the production of biodieselfrom *Jatropha curcas* were catalyst concentration (g),

Table 1: Raw materials for production of biodiesel.

Edible oil	Nonedible oil	Animal fats	Waste and algae
Palm, peanut, rice bran, soybean, canola, coconut, palm, o live, grape seed, rapseed, sorghum, safflower, barley, groundnut and many more.	Jatropha, karajaer, neem, jojoba, linseed, tobacco seed oil, mahua, pongamia, sea mango,	Tallow, yellow grease, chicken fat and by product of the refining vegetable oils.	Waste cooking oil and algae

Table 2: Production of oil from different seed.

S #	Plants seed name	Oil % in seed	Yield of oil tons/ha/year	Seed yield ton/ year x 10^6	Reference
1	Linseed	35 to 40	0.5 to 1.0	0.15	May *et al*., 2011
2	Mahua	35 to 40	1.0 to 4.0	0.20	
3	caster	45 to 50	0.5 to 1.0	0.25	
4	Jatropha	50 to 60	2.0 to 3.0	0.2	
5	Karanja	30 to 40	2.0 to 4.0	0.06	

Table 3: Fatty acid formation of jatropha curcas oil.

Fatty acid	Composition wt%
Palmitic	14.1 to 15.3
Stearic	3.9 to9.8
Eicosenic	0.160
Behinic	0.183
Polmitolic	0.499
Arachidic	0.3
Oleic	41.39
Linoleic	37.95
Gamma. Linolenic	0.307
Myristic	0.1

Mureed *et al.*, 2016.

Figure 1: Jatropha seed plant.

reaction temperature, oil to methanol molar ratio, reaction time, mixing rpm, pH and composition of fatty acid in oil raw material. Oil was obtained from jatropha seed plant and purchased from Kh herbals which deal all kind of essential oil, herbal extracted and cold press oil from Lahore. The extracted oil have some dark brown colour. In this experiment NaoH used as a catalysts. NaoH was manufactured by duksan company and purchased from Khan associate Lahore. Methanol is used with oil in different molar ratio on specific reaction time. Three (3) gm NaoH used as a catalyst with 10ml of methanol in 100 ml jatropha oil at 65 °C temperature, agitate it for reaction time was 1 to 2 hr for better result and leave for settle down of oil and glycerine, in previous research the reaction time consider from 45 minutes to 24 hr at different temperature 25 to 65 °C. Magnetic stair was used for proper mixing at 500 rpm for some time mixed it for good reaction and leave it for 4 to 5 hours to settle down. Two layers was obtained upper layer is biodiesel and lower glycerine, filtrate it with the help of filter paper. Remove glycerine and some other properties distilled water was used in when oil and water layer were formed oil separated from water easily. In this experiment 84% oil was obtained previous research have a result 90 to 98%, process performed at different temperature and methanol to oil ratio with reaction time.

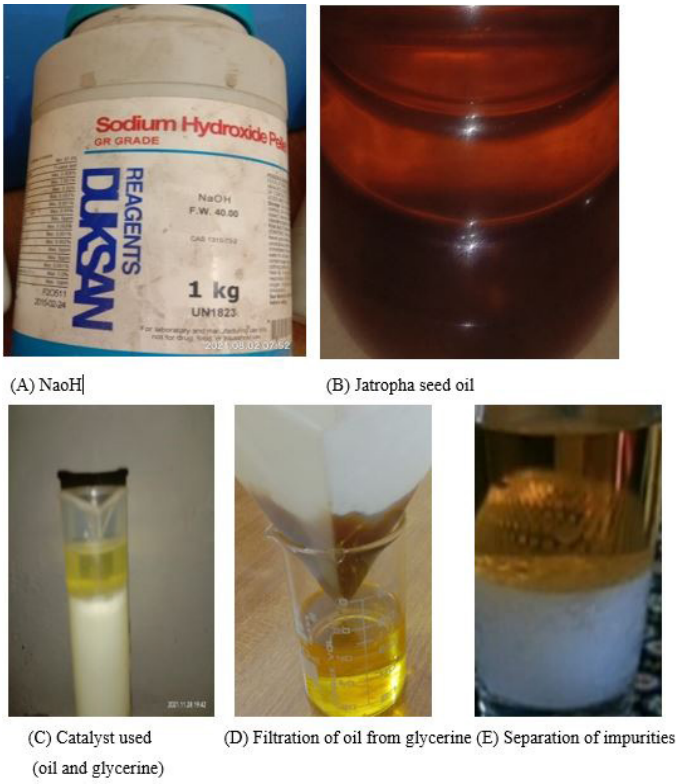

Figure 2: Production of Biodiesel from Jatropha oi.

Table 4: Production of Jatropha Oil by using different catalyst.

S. #	Type of catalyst	Methanol /oil molar ratio	Reaction temp (°C)	Reaction time (Min)	Catalyst loading	Yield %	Reference	Reference by
1	KOH	6:1	50	120	1.0% w/w	97	Berchman *et al.*, 2010	Ching *et al.*, 2011; Shuit *et al.*, 2009
2	KNO_3/AL_2O_3	12:1	70	360	6 wt%	87	Vyas *et al.*, 2009	
3	H_2SO_4	6:1	60	60	15% wt	99.8	Shuit *et al.*, 2009	
4	NaoH	9:1	45	30	0.8 %w/w	96	Tapanes *et al.*, 2008	
5	NaoH	24:1	250	28	0.8% w/w	90.5	Tang *et al.*, 2007	
6	Cao	9:1	70	150	15% wt	93	Zhu *et al.*, 2006	
7	NaoH	5.6:1	60	90	1.0%w/w	98	Chitra *et al.*, 2005	

2.1 Homogenous catalysts

The different homogenous catalysts with their catalytic activity shown in table with Biodiesel yield%. The factors effecting on the production of biodiesel from *Jatropha curcas* were catalyst concentration (g), reaction temperature, oil to methanol molar ratio, reaction time, mixing rpm, pH and composition of fatty acid in oil raw material.

2.2 Properties of jatropha oil

The most desired properties of the materials, products and industrial process are sustainability, eco-friendly and industrial ecology. The main properties of Biodiesel from Jatropha oil represent in Table 2.

Table 5: Biodiesel from Jatropha seed properties.

Property	Unit	Jatropha
Calorific value	Mj/kg	39.2
Flash point	°C	135
Pour point	°C	2
Cloud point	°C	--
Cetane num	--	61
Viscosity	Mm^2/s	2.37
Density	Kg/m^3	880
Carbon residue	Wt%	0.20
Sulfur	Ppm	--
Water	%	0.025

Conclusions and Recommendation

Energy requirement, fuel prices, global warming, emission of greenhouse gases and decrease the sources of fossil fuel are the major problems of these days. There are many sources in the world to overcome the crisis of energy, Jatropha seed plant is one of them to produce energy. Jatropha oil was purchased from Kh herbals and used for purifaction, for this purpose transestrfaction method was used to separate glycerine from oil, in this purpose NaoH used as catalyst. Homogenous catalyst like as NaoH applied for the production of biodiesel from jatropha oil seed maximum recovery was 85%, reaction time 1 to 2 hr at 65 °C temperature. Government must support the researchers to find new sources of energy for their requirement.

Novelty Statement

To find Local energy Sources to meet the country demand.Biodisel blanded with diesel to decrese the price of petroleum products.Biofuels are environmental suntainable.

Author's Contribution

All authors contributed equally.

Conflict of interest

The authors have declared no conflict of interest.

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