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Review IJICEGT

Identification of Significant Parameters for the Production of Jatropha Biodiesel Using Preliminary Experimentation

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Abstract

The current research work is on Jatropha biodiesel for finding the significant parameters in optimum biodiesel yield. The one factor at a time approach is applied in the esterification. The trans-esterification reaction is used by mixing of Jatropha oil and ethanol in the presence of catalyst KOH. After some time two products are formed a Jatropha biodiesel and a glycerin. The density of glycerin is more as compared to biodiesel. Hence it is settle down in the beaker. The biodiesel is separate apart and cool down in another beaker. The water bath is then used to cool down the temperature of produced biodiesel. During the trans-esterification process it has been found from literature review that five process parameters are affecting the biodiesel yield which are ethanol to oil molar ratio, reaction temperature, reaction time, catalyst concentration and rpm of magnetic stirrer. It is observed from preliminary investigation that all the parameters are affecting the biodiesel yield as any one input parameter is increased and other four remains at constant value.

Keywords: CI engines, RSM, genetic algorithm, Biodesel, OFAT

INTRODUCTION

Energy is the most important input for the growth of every sector including industrial sector, transport services, agriculture etc. Around the world, the demand for energy is increasing continuously, specifically based on petroleum. The predicted shortage of petroleum and its products have increased the search for the substitute of petroleum derivatives. The fossil fuels are depleting day by day and there is a need to find an alternative fuel to fulfill the energy demand. Biodiesel is one of the best available sources to fulfill the growing demand of energy. It derives from animal fats, vegetable oils and waste cooking oils. Biodiesel is defined as the "mono alkyl esters of long chain fatty acids derived from renewable liquid feedstock's, such as vegetable oils and animal fats, for use in compression ignition (CI) engines." The biodiesels are environment friendly as emissions produced by CI engines running on these are lower.

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It is reported in the literature that biodiesel production from trans-esterification is mainly dependent on: type of alcohol, alcohol to oil molar ratio, type and amount of catalyst, reaction time, reaction temperature and mixing speed.

The mixing of alcohol, catalyst amount and oils (edible/non-edible) is not an easy task as alcohol is immiscible in oils. So, different setups are available to achieve trans-esterification process. These are: Magnetic stirrer, overhead stirrer, mechanical stirrer etc. The different optimization techniques like response surface methodology (RSM), genetic algorithm (GA), RSM-GA etc. [1–5] are used to find out the optimum trans-esterification process parameters.

Jatropha plants are found in almost every part of the world. The oil extracted from the respective seeds of plant is used for many purposes such as for lubrication in the engines, alternate fuels for diesel engine, medical purposes etc. Gandhi et al. [6] considered crude jatropha oil for biodiesel production by utilizing methanol and catalyst KOH. The optimum reaction variables were found to be: methanol to oil molar ratio of 7.5:1, catalyst to oil molar ratio 2.09 %w/w of oil and reaction temperature 60◦C.

The physiochemical properties met the ASTM standards. Bala et al. [7] investigated karanja oil for the biodiesel production and activities of resins "Amberlite IR 120 H, Amberjet 1200 H" in free fatty acid present in the oil. It was observed that FFA content was considerably reduced due to acidic ion exchange and optimum conditions for esterification of karanja oil were found to be 0.8% (w/w) catalyst amount, 1:6 methanol to oil molar ratio and 25 min reaction time for Amberlite IR 120 H and 1% (w/w) catalyst amount, 1:6 methanol to oil molar ratio, and 25 min reaction time for Amberjet 1200 H. This pretreatment reduces the complexity of the process and the production cost of biodiesel by alkaline catalyzed trans-esterification.

Karanja is medium sized tree and is found throughout India. The tree is drought resistant. Major karanja producing country are india, Philippines and east India [8].

It requires rainfall ranging from 500 to 2500 mm. It can grow on most soil types ranging from stony to sandy to clay but does not do well on dry sands. In its naturals habitat, the maximum temperture ranges from 27 ℃ to 38℃ and the minimum 1℃ to 16℃. The oil content varies from 27-39%. It is a legume tree that grows to about 15-25 meters in height with a large canpoy which spreads equally wide. Flowering starts generally after 3-4 years. Cropping of pods and single almonds sized seeds can occur after 4-6 years. Small clusters of white, purple ank pink flowers blossom on their branches throughout the year, which ultimately turns into brown seed pods. The tree is well suited to intense heat and sunlight. A thick yellow-orange to brown oil is extracted from seeds. Yields of 25% of volume are possible using a mechanical expeller. The oil is a bitter taste thus, it is not consider edible. In india, the oil is used as afuel for cooking and lamps. The oil is also is used lubricant, water-paint binder, pesticide and in soap making and tanning industries. The oil of karanja when converted to biodiesel can also be used as substitute for diesel.

Before conducting the experiments, some devices and instruments used for measuring various parameters like viscosity, density etc. Some were directly measured by experimental setup devices and some were measured using external devices.

When density of a fluid relative to density of standard fluid i.e. water, air is measured, it is called Specific gravity. How much a substance occupies mass per unit of volume is defined as density. Hydrometer is used to measure density of different blends. Different blends were taken in jar one by one and hydrometer dipped into it and reading was taken with the help of marking on hydrometer [9].

USED COOKING OIL PRODUCTION

Used cooking oil was converted into biodiesel using the trans esterification process. Utilizing a cone-shaped apparatus with a reflux condenser, thermometer, and appealing stirrer, a trans esterification approach was run. The flagon was heated to 65°C and accused of wasting cooking oil. Used cooking oil was treated with sodium hydroxide (NaOH), which was added in a 6:1 methanol to used cooking oil ratio as an energizing agent. A 1.5-hour response time was set for a meth-oxide arrangement in a carafe. A pipe for isolating the mixture was then filled to separate the biodiesel from the glycerol. The biodiesel is then repeatedly washed with warm corrosive water that is 5 percent corrosive. The remaining methanol, impetus, and water were removed from the biodiesel using a rotary evaporator with an 80°C temperature setting. The utilized cooking oil-derived biodiesel methyl was dried at 100 °C. Biodiesel is blended with diesel oil at different volumes of 5, 10, 15, and 20% [10].

PROS AND CONS OF UTILIZING BIODIESEL AS FUEL

Unlike alternative different fuels used, biodiesel has additionally each the benefits and drawbacks. A number of the benefits of biodiesel as a substitute for fuel are:

1. It's low toxicity, as compared with the fuel.
2. It's renewable supply of energy that obtained from vegetable oils or animal fats.
3. The contaminants like particulate stuff, carbon monoxide gas, hydrocarbons and aldehydes are less emitted.
4. It will scale back warming gas emission too and its energy economical.
5. Reduced emissions of cancer substances cause lower health risk.
6. Biodiesel is taken into account non-toxic and perishable. No sulphur dioxide emissions.
7. It's emulsified at any proportion with diesel, each the fuels are also mixed throughout the fuel provide to vehicles.
8. Wonderful properties as a lubricating substance.
9. It's the sole different fuel that may be utilized in internal-combustion engine.
10. Used change of state oils and fat wastes process can even became processing base material.
11. It holds good potential as simulating the property rural development and resolution for energy security issue.

Disadvantages

Because of low heat worth of biodiesel fuel consumption is slightly high. NOx emission is slightly high than diesel fuel.

Melting point is high, which could be inconvenient in cold climates. Stability is less than diesel, thus long storage (after six months) of biodiesel isn't instructed. It is going to be degrading rubber and plastic gasket and hoses to once utilized in pure type in this case Teflon elements is advocated.

The biofuel can dissolve the debris sticked in to the fuel line which could choke the injectors. In this case the improvement of tank before filling with biodiesel is planned. Following a comprehensive research of the current literature, numerous gaps happen to be observed in overall performance evaluation associated with internal ignition engine utilizing alternative fuels.

Researches have been done upon single and four-cylinder engine making use alternative fuel using modelling optimization of engine using different biodiesel. Materials review shows that investigation had been performed using mixing of biodiesel with additive but restricted work continue to be reported in blending combining with castor-karanja oil. Castor oil used with different blends but no work is reported using castor –karanja oil using RSM.

PRELIMINARY INVESTIGATIONS FOR BIODIESEL PRODUCTION

Optimum production of biodiesel from various oils requires an appropriate selection of setup parameters and additives. This can be achieved by understanding the interrelationship between large numbers of parameters affecting the trans-esterification process. The experiments have been performed in a magnetic stirrer setup available in U.I.E.T, M. D. U, Rohtak, Haryana (India)

The primary aim is to optimize the process parameters to enhance biodiesel production from various oils. This can be done by considering various techniques of optimization. Different parameters are found that affect the biodiesel synthesis and therefore deep study is essential in optimizing the trans-esterification process parameters. These parameters are: Ethanol to Oil molar ratio (MR), reaction time (Rt), reaction temperature (RT), catalyst concentration (CC) and mixing speed (MS).

The optimum ranges of parameters (from preliminary investigations) are shown in Table 1 along with notations.

It is observed from Figures 1–5 that all the parameters are affecting the biodiesel yield by changing one factor at a time and keeping other parameters constant.

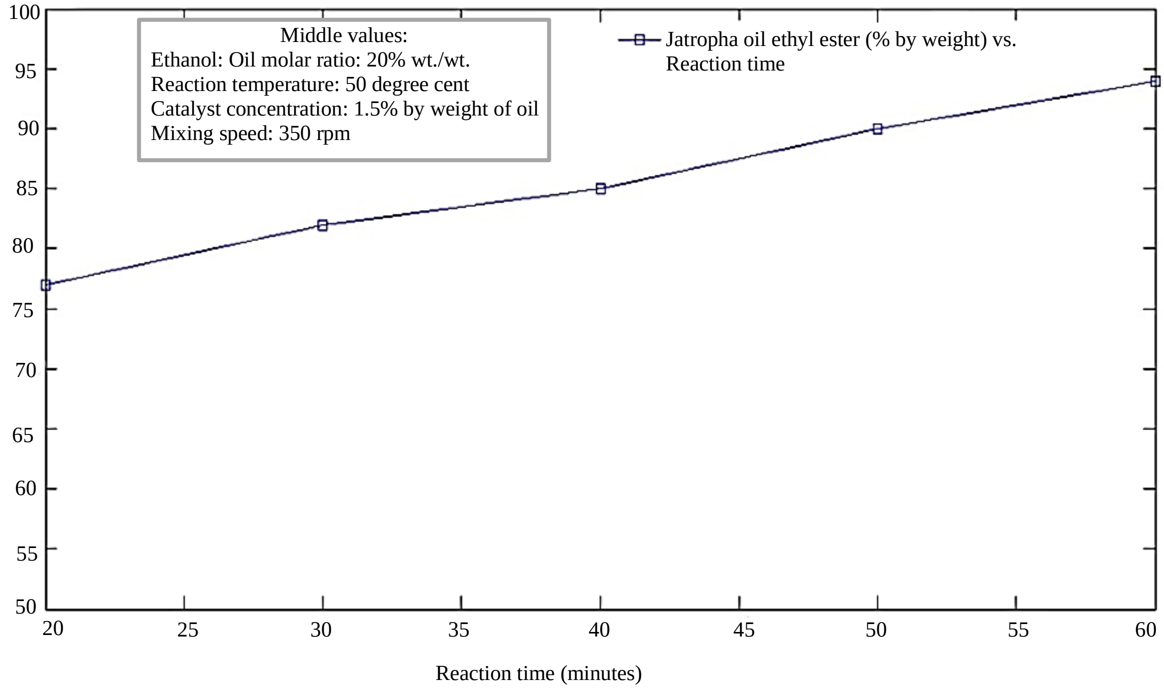

Figure 1. Variation of biodiesel yield by changing the reaction time.

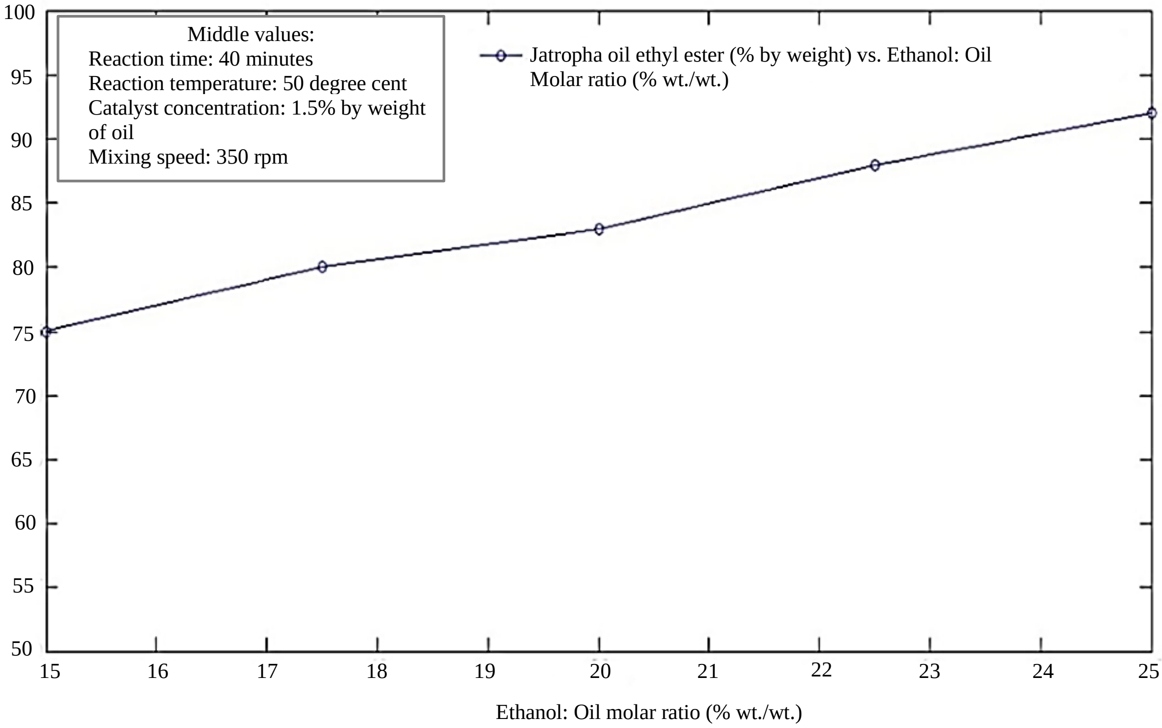

Figure 2. Variation of biodiesel yield by changing the blending ratio.

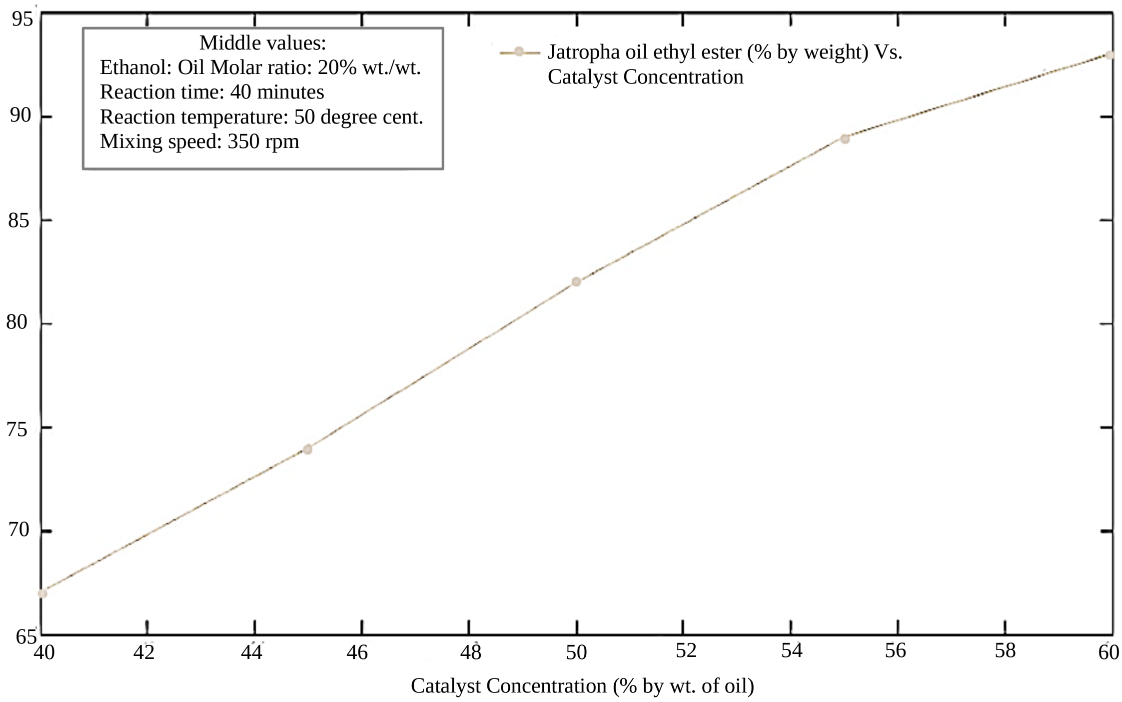

Figure 3. Variation of Biodiesel Yield by changing the catalyst concentration.

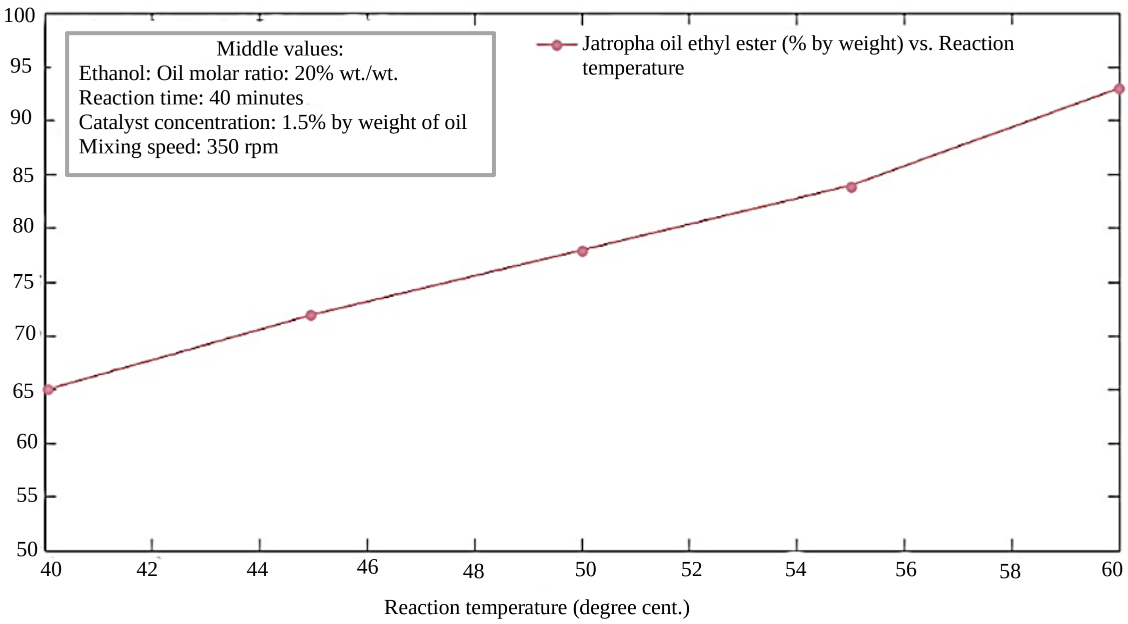

Figure 4. Variation of biodiesel yield by changing the reaction temperature.

Table 1. Parameters for biodiesel production and their limits.

S. No.	Name	Notation	Units	Range
1	Ethanol to Oil molar ratio	MR	% V/V	15-25
2	Reaction time	Rt	Minutes	20-60
3	Reaction temperature	RT	˚C	40-60
4	Catalyst concentration	CC	% by weight of oil	0.5-2.5
5	Mixing speed	MS	rpm	150-550

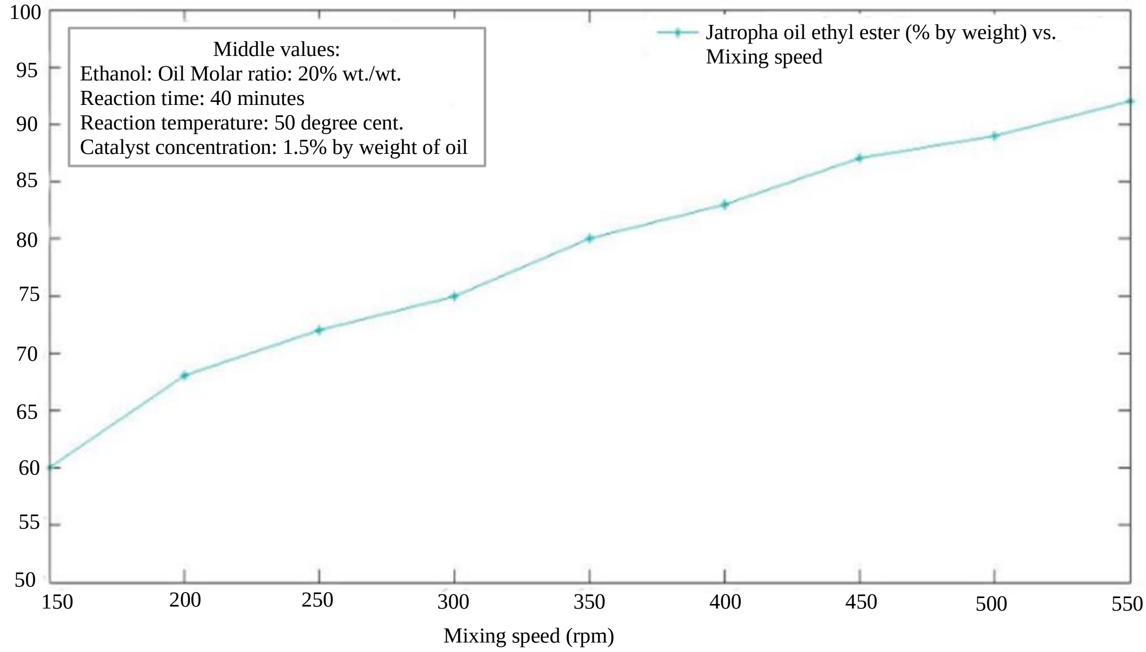

Figure 5. Variation of biodiesel yield by changing the mixing speed.

CONCLUSION

1. The One Factor at a time (OFAT) approach is the significant method for selection of input parameters in order to produce Biodiesel.
2. The value of constant input parameters are to be selected middle vaue of the range predicted from the past research.

REFERENCES

1. Lee, H.V., Yunus, R., Juan, J. and Taufiq, Y., (2011), "Process optimization design for jatropha-based biodiesel production using response surface methodology", Fuel Processing Technology, Vol. 92, pp. 2420-2428
2. Volli, V. and Singh, R. K., (2012), "Production of bio-oil from mahua de-oiled cake by thermal pyrolysis", Journal of Renewable & Sustainable Energy, Vol. 4, 013101. DOI: 10.1063/1.3676074.
3. Duan, X., Peng, C., Srinivasakannan, Zhang, L., Xia, H., Yang, K. and Zhang, Z., (2011), "Process optimization for the preparation of activated carbon from jatropha hull using response surface methodology", Energy Sources, Part A: Recovery, Utilization and Environmental Effects, Vol. 33, No. 21, pp. 2005-2017.
4. Rajendra, M., Jena, P. C. and Raheman, H., (2009), "Prediction of optimized pre-treatment process parameters for biodiesel production using ANN and GA", Fuel, Vol. 88, No. 5, pp. 868-75.
5. Weng Hui, L., (2012), "Case study of artificial neural network modelling on catalysed and enzymatic trans-esterification process for biodiesel production", Journal of Applied Science & Research, Vol. 8, No. 3, pp. 1672-1681.
6. Gandhi, S., Chelladurai, S. and Kumaran, S., (2011), "Process optimization for biodiesel synthesis from Jatropha curcas oil", Distributed Generation & Alternative Energy Journal, Vol. 26, No. 4, pp. 6-16.
7. Bala, V. S. S., Thiruvengadaravi, K. V., Kumar, P. S., Premkumar, M. P., et al., (2012), "Removal of free fatty acid in Pongamia Pinnata (Karanja) oil using divinylbenzene-styrene copolymer resins for biodiesel production", Biomass and Bioenergy, Vol. 37, pp. 335-341.
8. Khayoon, M. S., Olutoye, M. A. and Hameed, B. H., (2012), "Utilization of crude karanja (Pongamia pinnata) oil as a potential feedstock for the synthesis of fatty acid methyl esters", Bio resource Technology, Vol. 111, pp. 175-179.

9. Wang R., ZhouW., Hanna M. A., Zhang Y., Bhadury P. S.,Wang Y., Song B. Yang, S., Biodiesel preparation, optimization, and fuel properties from non - edible feedstock, Datura stramonium L. Fuel, 2012, 91, 182 – 186
10. Freitas S. V. D., Pratas M. J., Ceriani R., Lima, A. S., Coutinho, J. A. P., Evaluation of predictive models of the viscosity of Biodiesel Energy, Fuels, 2011, 25 (1), 352 – 358

