International Journal of Engineering Research ISSN:2319-6890)(online),2347-5013(print)
Volume No.4, Issue No.3, pp : 105 - 110 01 March. 2015

Comparative Analysis of Biodegradability of Biodiesel obtained by Conventional and Non-Conventional Methods

Nagaraja Y. P[1] & Chandrashekhar Biradar[2]
Department of Biotechnology, Nagarjuna College of Engineering and Technology,
Venkatagirikote, Devanahalli, Bengaluru– 562 110, Karnataka, India

Abstract: Biodiesel is an alternative to conventional diesel fuel made from renewable resources. No engine modifications are required to use biodiesel in place of crude oil-based diesel. The use of biodiesel resulted in lower emissions of unburned hydrocarbons, carbon monoxide and particulate matter. Biodiesel also increased catalytic converter efficiency in reducing particulate emissions. Chemical characterization also revealed lower levels of some toxic and reactive hydrocarbon species when biodiesel fuels were used. In the present work, biodiesel is produced by both conventional and non-conventional methods to determine the biodegradability effect using microorganisms obtained from soil collected from the vicinity of a petrol bunk. Also, effect on biodegradability of the biodiesel is studied by the addition of additives and on biodiesel blends especially Honge oil. The distinct advantage of using the oil was that it was cheaper and highly economical in the long run.

Keywords : Biodiesel, Hongeoil, Biodegradability, NMR, Additive

I. INTRODUCTION

Biofuel industries are expanding in Asia, Europe and almost world-wide. Recent technology developed at Los Alamos National Lab even allows for the conversion of pollution into renewable biofuel. When liquid and gaseous biofuels from vegetable oils are heated, their viscosity is reduced and they can be burned directly in a diesel engine, or they can be chemically processed to produce fuels such as biodiesel. It is also possible to make cellulosic ethanol from non-edible plant parts. Biodiesel is the most common Biofuel and is produced from oils or fats using transesterification [10]. Feed stocks for biodiesel include animal fats, vegetable oils, soy, rapeseed, Jatropa, mahua, mustard, sunflower, palm oil, *Pongamia pinnata* and algae, [3,11-13].

Honge Oil

Honge (*Pongamia pinnata* Linn.) oil is derived from the seeds of the *Pongamia* tree, native of tropical and temperate Asia. The oil is yellowish-orange to brown in color. It is toxic and will induce nausea and vomiting if eaten but it is used in many traditional remedies. The oil has high content of triglycerides, bitter flavonoid constituents including karanjin and karanjachromene [17]. Honge oil contains fatty acids like palmitic acid (C16.0), stearic acid (C18.0), oleic acid (C18.1), Linoleic acid (C18.2), Linolenic acid (C18.3), Arachidic acid (C20.0), Eicosenoic acid (C22.0), Lignoceric acid (C24.0) and the percentage of 11.6% , 11.6%, 51.5%, 16.0%, 2.6%, 1.7%, 1.1%, 4.3%,1.0% respectively [14].

Biodiesel Blends: Biodiesel blends are prepared by mixing biodiesel with natural diesel obtained from crude oil like B20 (20% biodiesel, 80% petroleum diesel), B5 (5% biodiesel, 95% petroleum diesel) and B10 (10% biodiesel, 90% petroleum diesel). Biodiesel can be blended and used in different concentrations, including B100 (pure biodiesel), B20 (20% biodiesel, 80% petroleum diesel), B5 (5% biodiesel, 95% petroleum diesel) and B10 (10% biodiesel, 90% petroleum diesel). B20 is a common biodiesel blend in the United States [12]. The major additives include Butylatedhydroxyanisole (BHA) and Butylatedhydroxytoluene (BHT) Eucalyptus oil [15].

II. MATERIALS AND METHODS

In the present investigation the following materials and methods are followed for the Production of Biodiesel from the raw materials includes Alcohol: (99% assay) E.Merck (India) Ltd, LR grade. Catalyst: Potassium hydroxide (84 % assay) E.Merck (India) Ltd, LR grade and the Honge oil (Double refined) were collected from Yelahanka, (Bangalore) Local market,

Microbial strains: the microbial strains includes *Pseudomonas aeruginosa, Enterobacter Proteus vulgaris Proteus mirabilis* were obtained from Chandigarh and used for the biodegradation.

Production of Biodiesel

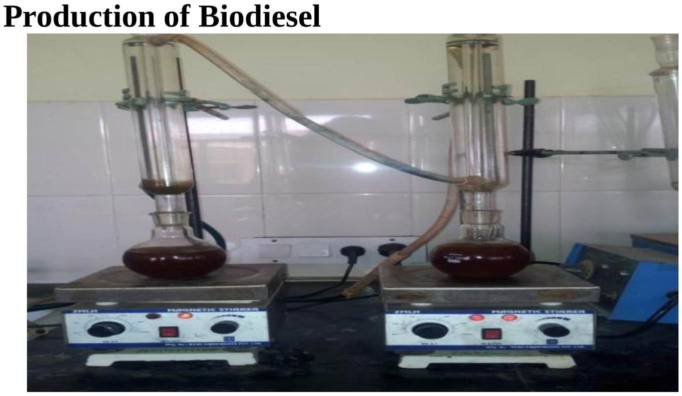

Fig: 1 Setup for production of biodiesel using a magnetic stirrer.

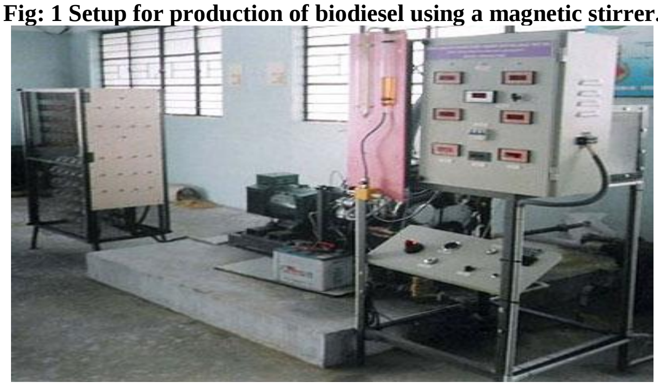

Fig.2 Multi Cylinder Diesel Engine Test Rig.

The biodiesel was produced by transesterification method.100ml hongeoil was heated and mixed with 33ml methanol and 1gram of potassium hydroxide together in a round bottomed flask which was kept on magnetic stirrer (Fig-1). The reaction was carried out for two hours at 60°C .the biodiesel was separated from glycerol using separating funnel. In non-conventional method the same procedure was followed in microwave reactor in a batch mode. Each batch was heated for 30seconds consuming 20amperes. The biodiesel so produced was washed ,heated in order to remove traces of water and other impurities [7].

Engine Test

To study the feasibility of Honge oil biodiesel as a fuel in diesel engine, engine test was carried out using Multi Cylinder Diesel Engine Test Rig (Fig- 2). The Exhaust Gas Temperature (EGT) is to be measured using chromelalumel thermocouple. The fuel flow rate was measured on the volumetric basis using a burette and a stopwatch. Other parameters such as the brake thermal efficiency and volumetric efficiency were also measured [1,5].

Isolation and Culture of Microbial Colonies

The microbial strains that were used for biodegradation includes *Psedomonas aeruginosa* and *Proteus vulgaris* were isolated from the sand that was collected from a petrol bunks near Yelahanka, Bangalore, India. The isolation was done by serial dilution method. Screening and identification of microorganisms were done by employing staining and biochemical tests [18].

Biodegradation

The biodegradation was done for the adapted and non-adapted strains. The adapted strains were isolated from the surroundings of a petrol bunks and non-adapted strains procured from Acharya College of Engineering and Technology, Bangalore. Initial tests were carried out for checking growth on a medium containing the biodiesel and the detection of biodegradation was done by determining the amount of CO_2 produced [6].

Detection of CO_2

Procedure: The shake flask set up consisted of a 250ml conical flask with nutrient medium, $Ba(OH)_2$ suspended into the flask, and a venting tube. The process is run for a period of 20-28 days during which periodically the $Ba(OH)_2$ is taken out and titrated against 0.1N HCl. The reservoir is refilled with fresh $Ba(OH)_2$. All the samples were analysed at time zero and at least four other times in a 28 day period to allow for a smooth biodegradation plot [8,9].

Biodiesel Blends: Biodiesel blends are prepared by mixing biodiesel with natural diesel obtained from crude oil like B20 (20% biodiesel, 80% petroleum diesel), B5 (5% biodiesel, 95% petroleum diesel) and B10 (10% biodiesel, 90% petroleum diesel). Biodiesel can be blended and used in different concentrations, including B100 (pure biodiesel), B20 (20% biodiesel, 80% petroleum diesel), B5 (5% biodiesel, 95% petroleum diesel) and B10 (10% biodiesel, 90% petroleum diesel). B20 is a common biodiesel blend in the United States.

Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test

In this a copper strip is heated for a few hours continuously in the biodiesel tested and the colour change in the strip is compared with the standards (Table-2).

Additives:

The major additives includes Butylatedhydroxyanisole (BHA) and Butylatedhydroxytoluene (BHT) Eucalyptus oil were prepared 500ppm, 750ppm, 1000ppm of both the additives used in the present investigation.

III. RESULTS AND DISCUSSION

Production of Biodiesel.

The production of biodiesel using Honge oil was done using two methods viz., conventional and non-conventional methods. The amount of biodiesel produced using non-conventional method was 40ml(before washing) and 35-38ml(after washing) for every 100 ml of the honge oil. The amount of biodiesel produced using conventional method was 35-40ml (before washing) and 33-35ml(after washing) for every 100 ml og honge oil.

Study of Physical Parameters and Characterization of the Biodiesel:

The following physical parameters and characterization of the biodiesel was observed according to the Aldo Okullo, *et al.*, [2] method. And the results are tabulated below, the parameter of the biodiesel includes the determination of viscosity, density, flash point, acid value, chemical composition of the honge oil, corrosivity etc [16] (Table-1).

Table 1: Physical parameters

Features	Conventional Biodiesel	Non-conventional Biodiesel
Color	Dark golden brown	Light golden brown
Density (kg/m³)	892	872
Viscosity (m²/s)	5.27×10^{-6}	13.3×10^{-6}
Flash Point	179-181	178-180

Chemical Composition of Honge Oil:

Composition of the honge oil was also qualitatively determined with the help of NMR analysis the result is predicted below (Fig-3).

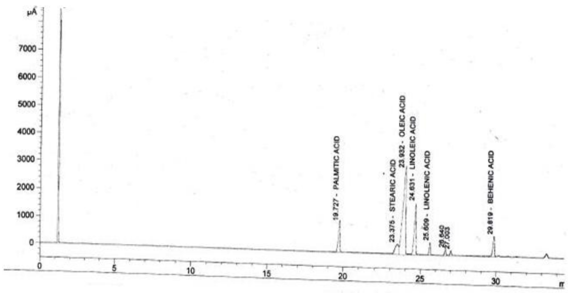

Fig-3Engine Test :

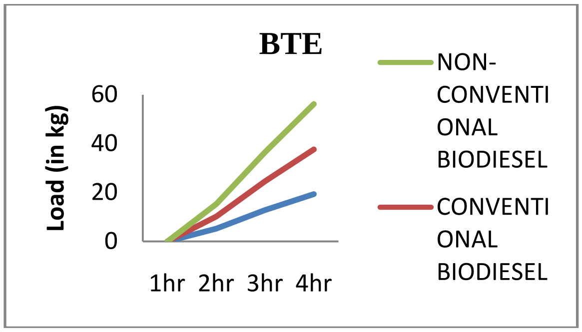

Fig.4. load v/s Brake Thermal Efficiency(BTE)

As seen from the graph above break thermal efficiency of the non-conventionally produced biodiesel is high. The higher the break thermal efficiency the better is the performance of the engine when supplied with a fuel.

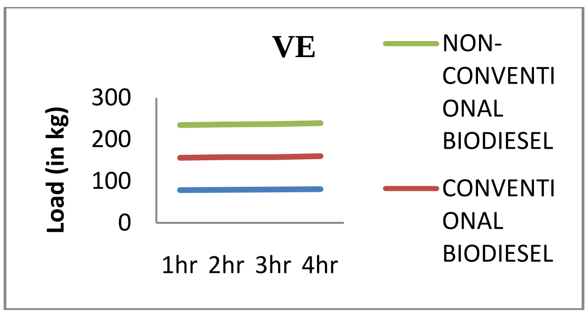

Fig.5 load v/s Volumetric Efficiency (VE)

The volumetric efficiency of the non-conventionally produced biodiesel being high makes it the most appropriate choice of fuel amongst the three.

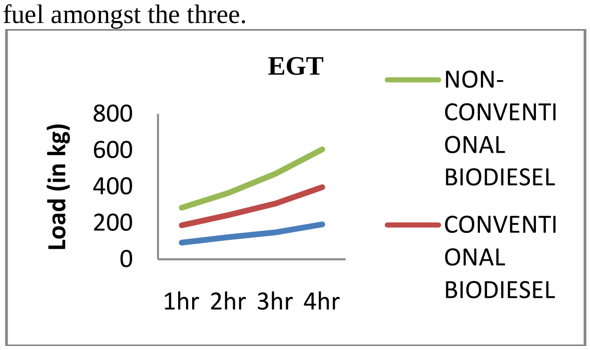

Fig.6. load v/s Exhaust Gas Temperature (EGT)

The exhaust gas temperature should always be low and as represented above the exhaust gas temperature for conventionally produced biodiesel is lesser than that of non-conventionally produced and thus making it more suitable for the engine to perform at higher speed and pressure.

Detection of Extent of Biodegradation with blends.

The biodegradation was found that out of the 8 colonies that were selected 5 showed positive results. These 5 strains were taken for the further tests. Non-adapted strains were chosen based on their biodegradation property. The selected strains were then streaked on to petri dishes containing growth medium and biodiesel. After 24hrs growth was seen on the petri dishes. After 48hrs of incubation it was seen that amount of biodiesel on the surface of the medium had reduced. And after 96 hrs of incubation, amount of biodiesel had reduced substantially. This indicated that the biodiesel did not inhibit the growth of these strains and also was readily biodegradable by these strains (Fig-7,8,9,10,11,12,13 &14) [12].

Fig.7. Non Conventional B_{15}

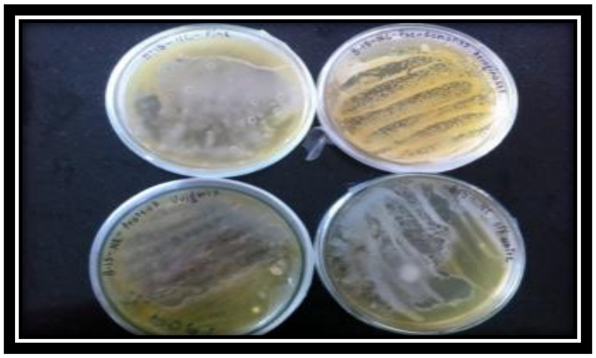

Fig.8.ConventionalB_{15}

Fig.9. Non-Conventional B_{20}

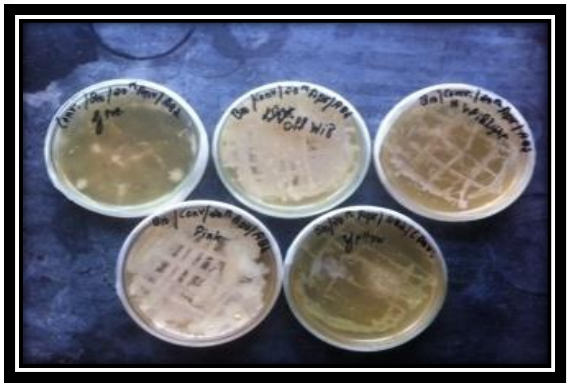

Fig.10. Conventional B_{20}

Fig.11. Non-Conventional B_5

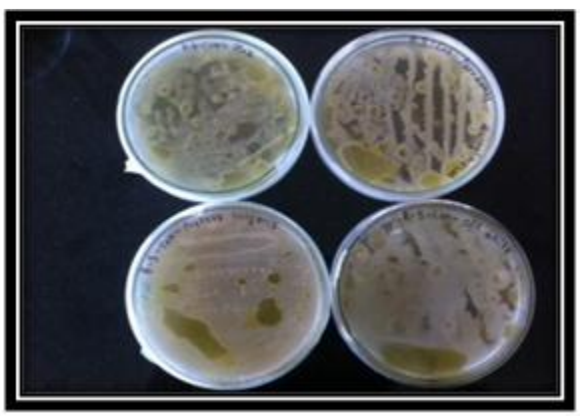

Fig.12. conventional B_5

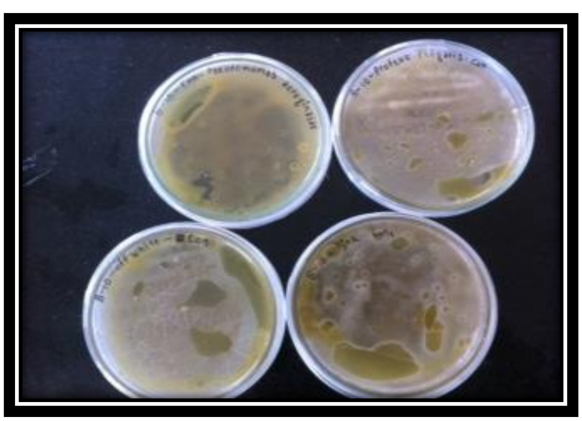

Fig.13 .Non-Conventional B_{10}

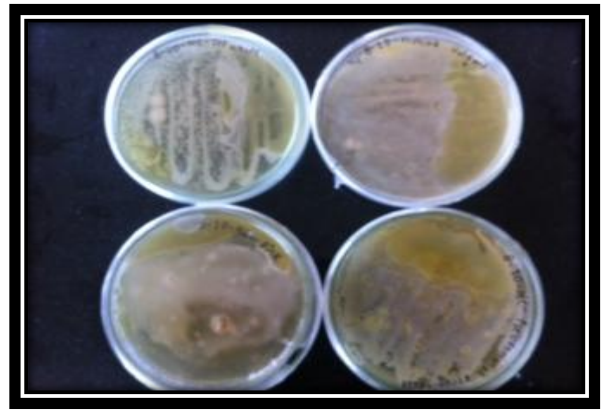

Fig.14 Conventional B_{10}

Simmon citrate test.

Biodegradation was done by streaking the isolated colonies and the colonies that reduced the oil content were then selected for further tests. The adapted strain of *Candida parapsilosis* strains was found to degrade the biodiesel very efficiently when compared to the remaining strains. The same was then chosen for the shaker flask studies to determine the amount of CO_2 evolved. The results are shown below (Fig-15).

Detection of CO_2.

The non adapted colonies were also checked initially to test if they can degrade and strains of *Pseudomonas aeruginosa* & *Proteus vulgaris* showed higher rate of consumption of biodiesel in the petri dishes were chosen for the shaker flask studies. The results are as shown in the graph (Fig-15). From the graph, it is observed that, the biodegradability of non conventional oil is better than that of conventionally produced biodiesel.

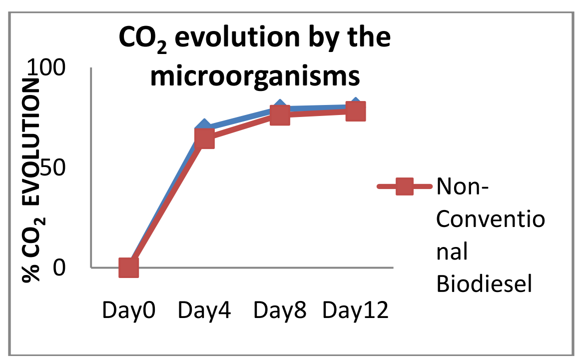

Fig. 15

Copper corrosion test:

In this method copper strip was heated continuously in the biodiesel and the colour change in the strip is compared with the standards. The Copper Corrosion assesses the relative degree of corrosivity of a petroleum product due to active sulfur compounds. Results are rated by comparing the stains on a copper strip to a color-match scale from 1-4. The Cu is dropped into a beaker containing biodiesel and found that there was no change in copper colour as shown below (Fig-16. Table-2) so the biodiesel is suitable for use in engine.

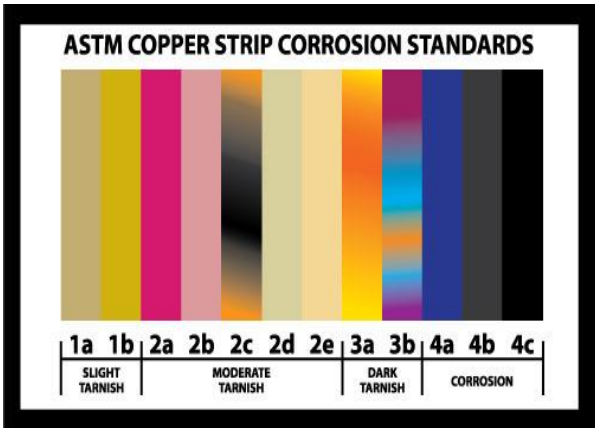

Fig. 16. Copper corrosivity test strip

Class	Designation	Description
1	Slight Tarnish	1a - Light orange, almost the same as the finely polished strip 1b - Dark Orange
2	Moderate Tarnish	2a - Claret red 2b - Lavender 2c - Multicolored with lavender blue and/or silver overlaid on claret red 2d - Silvery 2e - Brassy or gold
3	Dark Tarnish	3a - Magenta overcast on brassy strip 3b - Multicolor with red and green showing no gray
4	Corrosion	4a - Transparent black, dark gray or brown with peacock green showing 4b - Graphite or lusterless black 4c - Glassy or black

Table 2: copper corrosivity

Effect of Additives on Biodegradability:

The additives includes BHA and BHT were mixed with biodiesel (500ppm,100ppm,1500ppm) and their effect on biodegradability of the biodiesel were observed. This was done by spreading the biodiesel with the additive on a nutrient medium and then the nutrient medium was streaked with the microorganisms and the nature of their growth was observed (Fig.17 &18) [12].

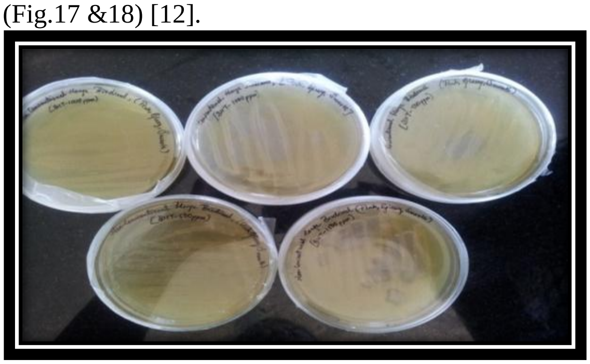

Fig.17 BHA

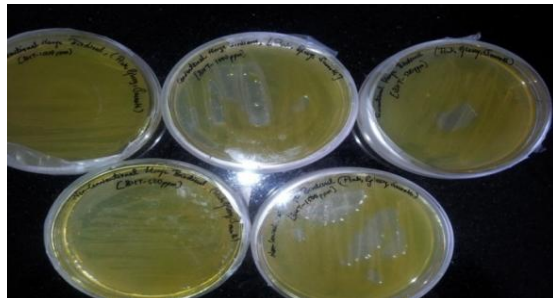

Fig.18 BHT

As observed the effect of additives the rate of oil reduction on the petriplates was more in non conventional biodiesel when compared to conventional biodiesel.

IV. CONCLUSION

The current investigation showed that the biodiesel production is more feasible by the non-conventional method as the Volume of biodiesel production was high in non conventional method when compared to that in the conventional method. The engine analysis showed that non-conventional biodiesel was a better choice in terms of volumetric efficiency and brake thermal efficiency, EGT. the amount of carbon dioxide produce was high The effect of additives, showed that the amount of oil reduction on the Petri plate in case of non conventional biodiesel was more than the conventional one However the biodegradation was high in B_{20} in both conventionally and non conventionally produced biodiesel. The copper corrosivity test proved that the biodiesel was suitable for use in the engine. It is concluded that non-conventionally produced biodiesel will be a better choice over the conventionally produced biodiesel.

Acknowledgement

The authors are grateful to the Acharya College of Engg & Technology for providing microbial strains. The authors also thank the Management and Principal of the Nagarjuna College of Engineering and Technology for their support and encouragement.

REFERENCES

i. Abdul Monyem, Jon H. Van Gerpen, , 2001,The effect of biodiesel oxidation on engine performance and emissions, Biomass and Bioenergy, 20(4), 317-325.

ii. Aldo Okullo, A. K. Temu, P. Ogwok, J. W. Ntalikwa, "Physico-Chemical Properties of Biodiesel from Jatropha and Castor Oils" Department of Chemical and Mining Engineering, University of Dar es Salaam-

iii. Tanzania, International Journal of Renewable Energy Research, Vol.2, No.1, 2012

iv. Aneja.K.R. Experiments in Microbiology, Plant Pathology and Biotechnology, 2005. New Age Publishers, 81-224-1494. p. 69.

v. Avinash Kumar Agarwal, K. Rajamanoharan. 2009. Experimental investigations of performance and emissions of Karanja oil and its blends in a single cylinder agricultural diesel engine, Applied Energy 86 106–112.

vi. FrancielleBücker, NaiaraAguiarSantestevan, Luiz Fernando Roesch, Rodrigo J. Seminotti Jacques, Maria do CarmoRuaroPeralba, FlávioAnastácio de Oliveira Camargo, FátimaMenezes Bento. 2011. Impact of biodiesel on biodeterioration *of stored Brazilian diesel oil, International Biodeterioration& Biodegradation, 65(1), 172-178.*

vii. *Karmee, Sanjib Kumar; Chadha, Anju. 2005. "Preparation of biodiesel from crude oil of Pongamiapinnata". Bioresour. Technol.96 (13). 1425–1429.*

viii. *Knothe, G. Biodiesel and renewable diesel. A comparison. Process in energy and Combustion Science. 2010. 36, 364-373.*

ix. *Malaya Naika, L.C. Meherb, S.N. Naikb, L.M. Das. 2008. Production of biodiesel from high free fatty acid Karanja (Pongamiapinnata) oil, Biomass and Bioenergy, 32. 354 – 357.*

x. *MaríaJesús Ramos, Carmen MaríaFernández, Abraham Casas, Lourdes Rodríguez, Ángel Pérez, Influence of fatty acid composition of raw materials on biodiesel properties, Bioresource Technology, 100(1), 2009, 261-268.*

xi. *Nagaraja, Y.P., Chandrashekar Biradar., K.S.Manasa and H.S. Venkatesh. 2014. Production of biofuel by using micro algae (Botryococcus braunii). International Journal of Current Microbiology and Applied Sciences. 3 (4):851-860.*

xii. *Sattanathan,R.,2015.production of biodiesel from castor oil with its performance and emission test.international journal of science and research .4(1).273-279.*

xiii. *Scott SA, Davey MP, Dennis JS, Horst I, Howe CJ, Lea-Smith DJ, Smith AG. 2010. Biodiesel from algae.challenges and prospects. Current Opinion in Biotechnology. 21(3).277-86.*

xiv. *Scott, Paul T.; Pregelj, Lisette; Chen, Ning; Hadler, Johanna S.; Djordjevic, Michael A.; Gresshoff, Peter M. 2008. "Pongamiapinnata. An Untapped Resource for the Biofuels Industry of the Future". BioEnergy Research1. 2.*

xv. *Barton, A.F.M and A.R. Knight. (1997) High-cineole eucalyptus oils in degreasing applications. Chem. Aust., 64(1). 4-6.*

xvi. *Nagaraja, Y.P., H.S. Venkatesh and M.S. Vinay. 2014. Production of biodiesel from poultry waste. International Journal of Pharma and Bio Sciences. 5 (2):791-799.*

xvii. *Anonymous., 2001. A dictionary of Indian raw materials and industrial products. The Wealth of inida, Vol-III Publication and information director, CSIR, New Delhi.*

xviii. *Aneja.K.R. Experiments in Microbiology, Plant Pathology and Biotechnology, 2005. New Age Publishers, p. 69.*