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A COMPARATIVE STUDY ON OPTIMIZATION OF ALKALI-BASE CATALYZED TRANSESTERIFICATION OF *JATROPHA CURCAS* SEED OIL

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ABSTRACT

To exceed the rising energy demand and reducing petroleum reserves, fuels such as biodiesel and bioethanol are in the forefront of the alternative techniques because current oil and gas reserves would suffice to lost only a few more decades. Biodiesel production is a very modern and technological area for researchers due to the relevance that it is winning everyday because of increase in the petroleum price and the environmental advantages. Alkali base catalyzed transesterification being the most commonly used method of Biodiesel production. It was observed that the yield of alkali base catalyzed transesterification of *Jatropha curcas* oil. Fatty acid methyl esters obtained by transesterification of *Jatropha curcas* seed oil gave performance and emissions characteristics close to that of Petrodiesel. Transesterification is a process, which brings about a change in the molecular structure of the vegetable oil molecules, thus bringing down the levels of the viscosity and unsaturation of vegetable oils. The viscosity of the oils gets drastically reduced after transesterification. This research deals with the optimization of protocol for Alkali-Based transesterification of Jatropha seed oil to form Fatty acid methyl esters.

KEYWORDS: *Jatropha curcas* seed oil, fatty acid methyl esters, biodiesel, petro diesel etc.

INTRODUCTION

In recent times, the world has been confronted with an energy crisis due to depletion of resources and increased environmental problems. The situation has led for search for an alternative fuel, which should be not only sustainable but also environmental friendly. For developing countries, fuels of bio-origin such as alcohol, vegetable oils, biomass, biogas, synthetic fuels etc. are becoming important. Such fuels can be used directly, while others need some sort of modifications before they are used as substitutes of environmental fuels. As per an estimate, India consumed about 40.34 million tons of diesels in 2000-2001, which was 43.2% of the total consumption of petroleum products. Biodiesel is defined as mono alkyl esters of vegetable oils or fats. Biodiesel is the best alternative for diesel fuel in diesel engines.[1,2,3,4]

Due to increase in the petroleum and the environmental concerns about pollution coming from the car gases, Biodiesel is becoming a developing area of high concern. There are different ways of production, with different kind of raw materials: refine, crude, or frying oils. One of the advantages of this fuel is that the raw material used to produce it is natural and renewable. All these type of oils came from vegetable or animal fat, making it biodegradable and nontoxic.[5,6,7] There are more than 350 oil bearing crops identified among which only soybean, sunflower, cottonseed, rapeseed and peanut oils are considered as potential alternative fuels for diesel engines Vegetable oil is one of the renewable fuels. Vegetable oils become more attractive recently because of their environmentally benefits and the fact that these are made from renewable resources. Vegetable oils are a renewable and potentially inexhaustible source of energy with energy content close to diesel fuel.[8,9,10]

Biodiesel is methyl or ethyl ester of fatty acid made from virgin or used vegetable oils (both edible and non-edible) and animal fat. The main resources for biodiesel production can be non-edible oils obtained from plant species such as *Jatropha curcas* (Ratanjyot), *Pongamia pinnata* (Karanj), *Calophyllum inophyllum* (Nagchampa), *Hevca brasiliensis* (Rubber) etc. Biodiesel can be blended in any proportion with mineral diesel to create a biodiesel blend or can be used in its pure form. Just like petroleum diesel, biodiesel operates in compression ignition (diesel) engine, and essentially require very little or no engine modifications because biodiesel has properties similar to mineral diesel. It can be stored just like mineral diesel and hence does not require separate infrastructure. The use of biodiesel in conventional diesel engines results in substantial reduction in emission of unburned hydrocarbons, carbon monoxide and particulate.[11, 12, 13]

Biodiesel as an alternative fuel for diesel engines is becoming increasingly important due to diminishing petroleum reserves and the environmental consequences of exhaust gases from petroleum-fuelled engines. Biodiesel, which is made from renewable sources, consists of the simple alkyl esters of fatty acids. As a future prospective fuel, biodiesel has to compete economically with petroleum diesel fuels.[14,15]

MATERIALS AND METHODS

Jatropha Curcas Seed Oil and Reagents

Jatropha curcas matured seeds were collected from the different areas of Agriculture College of Rewa City. The ripe seeds were collected and the damaged seeds were discarded. The screened seeds were cleaned, de-shelled and air dried in the shade for 5 days in this summer seasons May-June 2014.

Extraction of Material

100 gm of the grounded seeds were taken and were placed in the Soxhlet apparatus and the oil was extracted using petroleum ether as solvent. The assembly was made to run for 3 hours. Anhydrous Sodium Sulphate was added to remove any trace of moisture from the extracted solution. The oil was separated from the solvent using volumetric assembly. The crude oil was filtrated to remove solid impurities. Methanol (99.9% purity), toluene (99.9%purity), HCl (purity 37%), H2S04 (purity 498.9%), H3P04 (10% concentration), NaOH, (purity 99.9%), KOH (purity 99%), CH30Na (purity 99%), CH30K (purity 99%), CaCb (anhydrous 99%), Na2S04 (anhydrous 99%).[16]

Oil Extraction and Content

Extracting oil from Jatropha seeds can be done either with a manual press, such as the ram press, or with a mechanical press, such as the oil expeller. With mechanic expellers up to 75-80% of oil can be extracted. For research purposes, in their research on optimization and kinetics in the extraction of oil from Jatropha found Hexane to be the best solvent for the process as compared to petroleum ether.[17]

Calculation of Oil Content

Oil content determined by following methods of Mudge *et al* 1999, The percentage of oil content can be calculated as below % of oil = Wt of oil obtained in gm X 100 Wt of seed taken in gm After the oil had been obtained and its percentage of oil content is calculated the same is subjected to physiological test such as acid value test, iodine value test and saponifiacation value test Chemical Analysis of Seed Oil.[18]

Acid Value

Two gram of the pure oil was weighed accurately by transfer method into a 2S0ml conical flask. Neutral ethanol (20ml) was added by means of a pipette and the flask heated on a steam bath for 3min. Then the flask was cooled and the contents titrated with 0, l N alcoholic potassium hydroxide solution using phenolphthalein as an indicator. A blank titration was also conducted side by side.[19]

Iodine Value

Oil (0.2g) was weighed accurately by transfer method into a 2S0ml iodine flask and dissolved in chloroform (20ml). Wij's reagent (20ml) was added by means of a pipette. The flask was stoppered and kept in darkness for one hr. with intermittent shaking. Then l0% of potassium iodide solution (10ml) and 50ml of distilled water were added to the flask and mixture was shaken well. The liberated iodine was titrated with 0.1 N sodium thiosulphate solution using fresh starch solution as indicator. A blank titration was also conducted side by Side.[20]

Saponification Value

Two gram of oil was weighed accurately by transfer method into a 2S0ml round bottom flask. Freshly prepared 0.5 N alcoholic potassium hydroxide solutions (2Sml) was added to the sample by means of pipette and the mixture gently refluxed on a water bath using an air-condenser for one hr. Then the flask was cooled, after that the condenser tip washed with little distilled water and the contents were titrated with 0.5 N hydrochloric acid solution using phenolphthalein as indicator. A blank titration was carried out simultaneously.[21]

The Physicochemical Characteristics of *Jatropha curcas* l. Seed oil

To determine the industrial value of a particular oil or fat which IS dependent on composition and purity, a number of chemical tests are carried out to have quality control over fats and oils used as raw materials. These analytical methods includes saponification value and iodine value determination, the former gives an idea of the amount of alkali needed for converting a definite amount of fat or oil into soap and in detecting the adulteration of a fat or oil by one of lower or higher saponification value while the latter helps in finding the adulteration in a fat or oil and judging its suitability for raw materials. Another analytical method used for fats and oils analysis is the Acid value determination which gives the extent of rancidity of the stored oil or fat sample, thereby deciding on its suitability.[22] (table-8)

Esterification and Transesterification

Esterification and transesterification process In general, esterification and transesterification (two-steps) process have been proposed for reducing the high free fatty acid content of the oils. The many methods used in this process such as homogenous catalyst, heterogeneous catalyst and super- critical methanol transesterification. One-step esterification may not reduce free fatty acid due to high content of water produced during the reaction. This required about 2h for this process and water must be removed by separation funnel before adding the mixture in to oils for esterification.

Acid Catalyst Esterification

Acid catalyst esterification was used to reduce free fatty acids content to as after level for alkaline transesterification. Generally, sulfuric, hydrocholric, ferric sulfate, phosphoric and organic sulfonic acid have been used to reduce acid value for high free fatty acids and water of vegetable oils. Esterification process required 20: 1 methanol ratio to oil. This reaction indicated that higher molar ratio preferred to reduce acid value into desired limit before alkaline transesterification process. The process acid catalyst HCl and H2S04 are used for esterification with 9: 1M ratio of methanol tore fine *Jatropha curcas* and 1 %v/*v* acid catalyst were added to the pre-heated oils at 60^{o}C for 3hour under 1000 rpm stirring speed in a glass reactor.

Upon the completion of this reaction, the products were poured into a separating funnel to separate the excess alcohol, acid catalyst and impurities presented in the upper layer. The lower layer was separated and entered into a rotary evaporator and heated at 65^{0}C under vacuum conditions for lh to remove methanol and water from the esterified oil.

Alkaline Catalyzed Transesterification

Alkaline-catalyzed transesterification or alcoholysis is defined as the chemical reaction of alcohol with vegetable oils. In this reaction, methanol and ethanol as well as KOH and NaOH catalyst are the most commonly used alcohols because of their low cost and viability. The transesterification were carried out using homogenous method and four catalysts (NaOH, KOH, CH_3ONa, and CH_3OK) were used in this reaction.

RESULTS AND DISCUSSIONS

The alkali catalyzed transesterification results of *Jatropha curcas* were investigated by changing the catalyst KOH to oil ratios (% w/w*)* and methanol to oil molar ratios. At catalyst concentration 2.09%w/*w* of oil, the maximum methyl ester yield was achieved. Further increase in catalyst resulted in reduced biodiesel yield because of incomplete reaction due to soap formation at higher catalyst concentrations. It is also observed that the methyl ester yield was increased as the methanol to oil molar ratio was increased.

Maximum methyl ester yield was achieved at the methanol to oil molar ratio of 7.5: 1. Further increase in methanol to oil ratio resulted in small reduction of biodiesel yield. The maximum yield under the optimum conditions (KOH to oil ratio and the methanol to oil ratio were 2.1 % w/w of oil and 7.5: 1 molar ratio respectively) was 80.5%. The reason for low yields and the higher consumption of the catalyst and methanol in the transesterification process of *Jatropha curcas* oil was considered to be due to FFA. High FFA in the oil deactivates the catalyst and the addition of excess catalyst as compensation gave rise to the formation of emulsion [109] which increased the viscosity, leading to the formation of gels and the problems associated with glycerol separation and loss in ester yields.[23]

Base catalyzed Transesterification

Base catalyzed transesterification processing of *Jatropha curcas* oil is mainly affected by the catalyst to oil ratios, methanol to oil ratios and temperature of the reaction. The reactions were carried out with different catalyst to oil ratios (0.44% to 0.88% w/*w)* and methanol to oil molar ratios (4.21, 4.81, 5.41, 6.01, and 6.61) to investigate their influence on the biodiesel yield and the results are given in Figures 3 and 4. The optimum methanol to oil molar ratio was 5.41: 1 and the optimum catalyst to oil ratio was 0.55% w/w. At these optimum conditions the biodiesel wield was 93% which was higher than the yield of one step direct alkali catalyzed transesterification.

The total ester content, produced measured by GC was 97.3% *w] »:* and which meet the European standards for biodiesel (EN standards), mainly consists of Methyl oleate, methyl palmitate, methyl stearate, methyl linoleate Biodiesel production from high free fatty acid Jatropha curcas oil was investigated. In one step conventional base catalyzed transesterification, the presence of high free fatty acid concentration (8.67%) reduced the biodiesel yield significantly (80.5%). Therefore a two step acid pretreatment esterification and base catalyzed transesterification process was selected to improve the yield. During the first step the FFA concentration of Jatropha curcas oil was reduced to 1.12% and in the second step, alkali based transesterification gave 93% yield.

Basically the amount of catalyst had impact of conversion of esters during transesterification process, Owing to its high free fatty acid, the transesterification of used biodiesel catalyzed directly used longer reaction time and only lower biodiesel yield can be achieved, So, a two stage process is followed to convert the biodiesel accurately, First stage, an acid-catalyst (sulfuric acid) was used to esterify (pretreatment) with *Jatropha curcas* oil, For that, a neck flask with a water cooled condenser was filled with 200 ml of *J. Curcas* oil, 40 ml of anhydrous methanol and 4 ml of sulfuric acid (H_2S0_4). A very large number of potentially useful catalysts have been investigated as a means to enhance the reaction rate. Without added catalysts some degree of rearrangement can be obtained but only under extreme conditions of temperature and time, leading to undesirable effects such as isomerization, polymerization and decomposition .The most common method to produce biodiesel is transesterification of vegetable oils in the presence of a catalyst such as an acid, alkali, or enzyme.

A part from the now generally preferred catalysts, e.g. sodium methoxide and alcolates, alkali metal alkoxides are found to be more effective transesterification catalysts compared to acidic catalysts. Sodium alkoxides are the most efficient catalysts, although KOH and NaOH can also be used. Transmethylation occurs in the presence of both alkaline and acidic catalysts. Varied amount of methanol were reacted with 25g acid esterified oil (Table 4 and 5). The ratio adopted was the 4:5 cosolvent to methanol volumetric ratio. The methanol to oil molar rations that may be considered optimum, this fact were justified in the best ratio.

Temperature ranges were studied ambient temperature 25-30^{o}C and temperature near the boiling points of methanol and hexane 65^{0}C. Reactions at 65^{0}C were carried out in a round bottom flask with reflux condenser attachment to condense methanol and hexane vapors and return these to the reacting. In this process, the temperature ranges were in order to optimize biodiesel yield and that temperature can influence the rate of reaction. For all temperatures, alcohols to oil molar ratio was 6: 1 with potassium hydroxide concentration of 1 wt, % 60°C higher biodiesel yield than the temperatures of 60°C for used frying oil. After 20 min, biodiesel yields were better in wt. percentage with respect temperatures of 60°C. The biodiesel yields were in good wt % of biodiesel yield for the temperatures of 60°C.[24, 25]

Effect of Catalyst Amount

It is observed from (Figure 6) that with a higher catalyst amount, a greater mole percent conversion in the reaction was achieved within a shorter reaction time, However, after one hour the percent mole conversion stabilized for almost all catalyst mounts except when 2 wt% (based on wt of oil) catalyst amount was used. This indicates that 2\vt% potassium carbonate is not sufficient to catalvze the transesterification reaction, for one hour of reaction time.

In separate runs when the transesterification reaction was allowed to run for 10 hours using different amounts of catalyst, the results show that 6 percent potassium carbonate (wt% of Jatropha oil) gave the highest mole conversion (98.214%), when 100g of Jatropha oil was reacted with methanol at a 6: 1 methanol to oil molar ratio at a temperature of 60°C with stirring at 600 rpm for 5 hours (Table 6), The change in percent mole conversion was further checked by determining the conversion for the unwashed sample. It was found that the difference in percent mole conversion between washed and unwashed samples increased with an increase in the catalyst wt% (table 6, 7).

In this case, the experiments were carried out at 6: 1 molar ratio of alcohol to oil used 1 wt % of KOH, NaOH, CH30K, and CH30Na with varying temperature ranges shows the biodiesel yield with catalysts used with varying time in the molar ratio of 6: 1 at 60°C. KOH catalyst was the better biodiesel yield behavior than other catalysts used here [i.e. NaOH, CH30K, and CH_3ONa) and also higher time of mixing had proved higher biodiesel yield and the result indicates that hydroxides gave rise to higher percentages than the corresponding methoxides. These results are very similar to those found in the literature in transesterification processes with methanol and other alcohols that also concluded that potassium hydroxide was the best catalyst (table6, 7).

The reaction can be catalyzed by alkalis, acids, or enzymes. The alkalis include NaOH, KOH, carbonates and corresponding sodium and potassium alkoxides, such as, sodium methoxide, sodium ethoxide, sodium propoxide and sodium butoxide. Acid catalysts are usually sulfuric acid; sulfonic acids and hydrochloric acid, Alkali-catalyzed transesterification is much faster than acid-catalyzed transesterification and is more often used commercially. Thus secondary saponification might be responsible for significantly lower conversion of Jatropha oil to biodiesel when 7 wt% potassium carbonate catalyst was used instead of 6 wt%. Figure 5 also indicates that the amount of soap formation increased with time when excess amount of catalyst (7 wt %) was used for an extended time (5 hours).

When 1 wt% catalyst was used, the reaction intermediate formed was highly unstable in the presence of air and it was difficult to get repeatable results. This was an indication that 1 wt% catalyst was not enough to catalyze the reaction to produce the decrease in percent mole conversion for the unwashed sample was not due to any (biodiesel) degradation. This was confirmed by checking the percent molar conversion of the washed sample after an extended time 10 hours settling time of the reactor contents. For 2 and 7 wt% catalyst, the percent molar conversion of the washed sample (before settling) and of the washed sample after extended time (10 hours settling time of the reactor contents) was almost the same, Transesterification process at 6: 1 methanol to oil ratio.

The decrease in percent molar conversion at high catalyst amount was due to the reduction in the molar concentration of FAME in the biodiesel phase which resulted probably from the increased solubilization of soap and other components into the biodiesel phase. The qualitative soap presence also agreed with this conclusion. These results confirmed that the saponification reaction occurred during the transesterifcation reaction and that there were no side reactions during the settling of the biodiesel.

Present study showed that more than 99% of the total quantity of $KHC0_3$ generated in the above reaction remained in the solid phase along with unreacted potassium carbonate at room temperature (25°C). The phase distribution of KHC03 between solid and liquid phase promoted the shifting of the equilibrium of the reaction towards product formation according to Le Chatelier's principle. Increasing the temperature caused more KHC03 to dissolve into the liquid phase from the solid phase. This increased the rate of the reverse reaction, As a result, the concentration of CH_3OK decreased and, at the same time, the concentration of K_2CO_3 increased. However, $KHCO_3$ was found to be a poor catalyst with negligible catalytic activity when compared to that of K_2CO_3. This indicates that CH_3OK formed from the reaction between K_2CO_3 and CH_3OH is the main catalyst compound.[25]

Effect of Methanol to Oil Molar Ratio

Since excess amount of catalyst produces excess soap over time and yields lower conversion, it is necessary to obtain a higher conversion within the shortest possible time using a low amount of catalyst. For this, a fixed amount (4 wt% oil) catalyst was selected and the methanol to oil molar ratio was varied from 6: 1 to 11:1. The results showed that with the increase in the methanol to oil molar ratio, the percent molar conversion increased rapidly with time but after 1 hour the ultimate percent mole conversion was lower compared to that of using lower methanol to oil molar ratio. This showed that the methanol to oil molar ratio had an effect on the initial higher conversion of the oil to biodiesel but little or no effect at the later stage in the reaction (table-2,3 5).

Some studies have demonstrated that the saponification of glycerides by the alkali catalysts is much faster than the transesterification reaction at temperature above 60°C. Higher temperatures than 55°C accelerates the side saponification reaction of the glycerides. This may be also the reason for the observed lower conversion at the reaction temperature of 650C in the present study. In order to minimize methanol loss at a temperature higher than 60°C, we would have had to build a unit that could be pressurized to condense the methanol vapor and reflux it to the reaction zone. Our study did not explore this option. Thus operating the reactor under the conditions of the experiments at temperatures higher than 60°C was not economical (table-2).

Quality of the biodiesel

For a typical parameter combination of 6 wt % catalyst, 6: 1 methanol to oil molar ratio, 60°C and 10 hours reaction time, the quality of the biodiesel was analyzed. The compositions of the biodiesel are shown in a tabular form.

The acid number of the produced biodiesel was 0,54 mg KOH/g, whereas ASTM specified acid number should be 50 mg KOH/g. The viscosity at room temperature (25°C) was 5.97 cP. The fatty acid methyl ester composition of the produced biodiesel was used to predict the cetane number of the produced biodiesel using different correlations (Bamgboye and Hansen, 2008; Gerpen, 1996) as the conditions of these correlations were similar to the one here. The predicted cetane numbers using different correlations were 50.4, 50.61 and 53.19, which were very close, The total lycerin (free glycerin + monoglycerides) found in the biodiesel composition was also in the tolerable limit (0.24wt% max).

Table: 1 Characterization of *Jatropha curcas* Seeds.

S.N0.	Analytical Parameters	Values
1.	Weigh t of 1000 seeds	540.51g
2.	Volume of 1000 seeds	730.00 mL
3.	Oil content (% v /w)	46.31
4.	Moisture and volatilities (%w /w)	05.80
5.	Ash content (% w /w)	4.56
6.	Odure	Disagreeable
7.	Colour	Light brownish
8.	Taste	Bitter
9.	Protein % *w /w* (on dry basis)	22.50

Table: 2 Amount of oil and reagents used in determining the best methanol to oil molar ratio.

S. No.	Oil (g)	NaOH (g)	Mthanol (mL)	Hexane (mL)	Methanol: Oil
1	25	0.25	5.8	4.5	6:1
2	25	0.25	7.0	5.6	7.24:1
3	25	0.25	8.1	6.5	8.38:1

NOTE: Methanol to oil molar ratio is 7.24:1, NaOH as percentage of oil mass is 1% and temp is 25-30^{0}C

Table: 3 Amount of oil and reagents used in determining the best NaOH to oil percentage.

S. No.	Oil (g)	NaOH (g)	Mthanol (mL)	Hexane (mL)	Methanol: Oil
1	20	0.06	7	2.8	0.3
2	20	0.1	7	2.8	0.5
3	20	0.2	7	2.8	1.0

NOTE: costolvent to methanol volumetric ratio is 2:5, Methanol to oil molar ratio is 8:1 and temp is 25-30^{0}C

Table: 4 Amount of oil and reagents used in determining the best reaction temperature.

S. No.	Oil (g)	NaOH (g)	Mthanol (mL)	Hexane (mL)	Methanol: Oil
1	20	0.2	7	2.8	25-30
2	20	0.2	7	2.8	60-65

NOTE: Co-solvent to methanol ratio is 2:5, Methanol to oil ratio is 8:1 and NaOH as percentage of oil mass is 1%.

Table: 5 Impact of catalyst amount (60°C, 6:1 methanol to oil molar ratio) wt%.

S. No.	Weight of oil	Reaction time in hr.	Mole conversion (%)	Temperature °C	Methanol: oil molar ratio
1	1g	0	0	60^{0}C	6:1
2	2-3 g	0.1-0.2	15	60^{0}C	6:1
3	2-3g	0.2-0.3	25	60^{0}C	6:1
4	3-4 g	0.3-0.3	35	60^{0}C	6:1
5	4-5 g	0.5-0.6	45	60^{0}C	6:1
6	5-6 g	0.6-0.7	55	60^{0}C	6:1
7	6-7g	0.7-.08	65	60^{0}C	6:1
8	6-7g	1	75	60^{0}C	6:1
9	6-7g	1.2	85	60^{0}C	6:1
10	6-7g	1.4	100	60^{0}C	6:1

Table: 6 Impact of catalyst amount on % mole conversion of reaction (washed sample) after 5 hours.

Cleaned/Purified or without impurities sample				
S. No.	**Catalyst amount (wt% of Jatropha oil)**	**Average % mole conversion of the raw oil**	**Error %**	**Time**
1	1	2.51	1.63	5hr.
2	2	92.79	0.37	-
3	3	94.95	1.08	-
4	4	96.84	0.28	-
5	5	97.85	0.64	-
6	6	98.21	0.12	-
7	7	97.48	0.39	-

Table: 7 Impact of catalyst amount on the % conversion of the reaction (unwashed sample) after 5 hours.

	Unclean/non purified or with impurities sample			
S. No.	**Catalyst amount (wt% of Jatropha oil)**	**Average % mole conversion of the raw oil**	**Error %**	**Time**
1	1	-	-	5hr.
2	2	91.34	1.57	-
3	3	94.75	0.57	-
4	4	92.5	1.79	-
5	5	90.08	2.85	-
6	6	89.29	1.18	-
7	7	65.87	5.8	-

Table: 8 Physicochemical characterization of *Jatropha curcas* seed oil.

S.N0.	Physicochemical Parameter	Values for Oil
1.	Specific gravity	0.913 at 28^{o}C
2.	Refractive index	1.496 at 28^{0}C
3.	Acid number	(mg KOHm/g 36.461)
4.	Iodine value (mg/g)	104.46
5.	Saponification value (mg/g)	175.12
6.	Unsaponifiable matter (%)	1.02

CONCLUSION

The focus of the investigation carried during this work was oriented towards the conversion of high viscous oils to Biodiesel or Fatty acid methyl esters. Oils can be used as diesel fuel but due to high viscosity they cause many problems like poor atomization, incomplete combustion, leading to heavy smoke emissions and high flash point of oil attributes to lower volatility characteristics. The world is confronted with the twin crisis of fossil fuel depletion and environmental degradation. The indiscriminate extraction and consumption of fossil fuels have led to a reduction in petroleum reserves, so alternative fuels, energy conservation and management, energy efficiency and environmental protection have become very important in recent years. The increasing impact bill has necessitated the search for liquid fuels as an alternative to diesel, which is being used in large quantities on transport, agriculture, industrial, commercial and domestic sectors. So Biodiesel obtained from oils has been considered a promising option.

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