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PREPARATION PROCESS OF JOJOBA BIODIESEL AND ANALYSIS OF FUEL TESTING: A REVIEW

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ABSTRACT

Biodiesel have more and more importance as a fuel due to the depleting fossil fuel resources. Biodiesel is mono alkyl esters of long chain fatty acids which can be derived from renewable feed stock like edible oils and non edible oils. The Jojoba oil is extracted from the seeds of the Jojoba (Simmondsia chinensis Link Schneider), which grows in semi desert areas. The Jojoba oil-wax is mainly used in the cosmetics and pharmaceutical industry. This paper gives a review on process to convert the Jojoba oil-wax to biodiesel by transesterification of jojoba oil with methanol in the presence of various catalysts. The optimization of experimental parameters was established to achieve maximum yield of the product. The physical and fuel properties of jojoba biodiesel like density, dynamic viscosity, kinematic viscosity, pour point, cloud point, flash point, and acid number were determined by ASTM procedures and were found to be comparable to ASTM standards for diesels. This work examined jojoba (oil and cake) as possible alternative fuel sources. This research aims to study the possibility of using jojoba ethyl ester (JEE), and its blends with ethanol in diesel engines. The physical and chemical properties of the jojoba ethyl ester and its blends with ethanol in different ratios have been measured. The method of preparation of JEE by transesterification process is optimized to find the lowest proportion of ethanol that gives the best properties of ester. There is a need for future researches to reduce the pour point of JEE and its blends with ethanol. JEE and its blends with ethanol is a biofuel, which can be used in diesel engines. The variables affecting the yield of the biodiesel produced were studied. The variables investigated were reaction time catalyst concentration, temperature and methanol: oil molar ratio The true yield of biodiesel was determined according to GC-MS. From the results it is clear that the produced biodiesel fuel was in the recommended standards range of biodiesel fuel. Numerical correlation using regression analysis for the true yield of biodiesel produced in terms of the operating conditions of the transesterification process is presented.

Keywords: *renewable feed stock; transesterification; biodiesel; blending.*

I. INTRODUCTION

The consumption of petroleum oil has caused economic and environmental problems in the world. To reduce dependence on petroleum oil, development of renewable fuel such as biodiesel is very important. The advantages of biodiesel fuel include renewability, high biodegradability, high flash point and less emission of pollutants. Biodiesel is a fuel comprising of monoalkyl esters of long chain fatty acids derived from vegetable oil or animal fats. Jojoba (Simmondsia Chinensis) is a perennial shrub that grows naturally in the Sonora desert (Mexico) and in the south west of USA. Jojoba is now being cultivated in some countries such as Argentina, Israel, Pakistan and Africa. The jojoba seeds are nut shaped and round, 1–2 cm long, with red brown to dark brown color. Jojoba wax is a golden liquid that can be obtained by cool pressing or solvent extraction [1]. Jojoba seeds contain about 40–50% of unique oil–wax which is composed mainly of straight chain monoesters in the range of C20–C44. This oil–wax is used mainly in the cosmetics and pharmaceutical industry, as a lubricant, in furniture and floor waxes, auto polish and long-burning candles. Jojoba is 0.7–1.0 m high, easily recognized by its thick, leathery, bluish green leaves and dark brown nutlike fruit. It is a slow growing tree. Jojoba seeds contain premium oil with unique characteristics compared to many oil plants in the vegetable kingdom. Therefore, it seems to have exceptional commercial promise. Around the world are huge tracts of semi-arid land where jojoba has the potential to become an important cash crop. Jojoba has a good chance of being very profitable as it is robust, drought tolerant, grows in soils of marginal fertility, needs less water than many other crops, withstands salinity, apparently has a low fertilizer requirement and withstands desert heat without requiring much water or shade[2]. Vegetable oil extractions with propane + CO2 mixtures have shown good results. An extraction process was proposed to extract jojoba oil using propane + CO2 liquid mixtures at high pressure. The phase behavior of binary and ternary mixtures was studied at different temperatures, pressures and compositions, to determine conditions of good solvent power for non-flammable solvent mixtures. A differential mass transfer model used to fit the experimental data and to analyze the performance of the extractions[3].

The production of renewable energy and chemicals could be obtained through a jojoba biorefinery where valuable long chain alcohols would be obtained as main products and fatty acid alkyl esters as co-product. Jojoba is a perennial shrub that belongs to the Simmondsiaceae family. The production of oil in the extraction process of jojoba oil is usually from 45% to 55% and this oil is formed

by unsaturated long-chain esters from C20 to C44. This structure makes jojoba oil (JO) really interesting for partial substitution of sperm whale oil. The peculiar composition of JO has as a consequence of unique product obtained in the alcoholysis that consists of a mixture of fatty acid alkyl ester (FAAE) and long chain jojobyl alcohols (JA). In addition, the poor low-temperature properties in biodiesel can be solved using different improving additives. The viscosity of TJO (mixture of JA and FAAE), so far needs to be reduced so that it will be accepted by fuel properties standards, hence it should be reduced from more than 19 to lower than 7. The separation of JA as value-added products from FAAE (biodiesel) not only reduces the FAAE viscosity and improves FAAE low-temperature properties, also allows FAAE production to become more cost-effective. From a biorefinery perspective, it would be economically and environmentally beneficial to use the JO for production of JA as main product and FAAE as co-product. The transesterification of JO with different short-chain alcohols and followed by separation of the JA as added-value product, of the mixture formed, by two-step crystallization. The influence of JA separation and the alcohol moieties that comprise FAAE on these properties[4]. jojoba oil is one of the vegetable oils which is considered to be a renewable alternative energy resource and not yet widely known. The jojoba oil is in fact an oil–wax and it is not composed of triglycerides but of esters of fatty acids and fatty alcohols. The first search of the physical and chemical properties of jojoba oil and jojoba methyl ester (JME), and study of its effect on the performance of diesel engines and dual fuel engines has been done . It has been investigated for how to decrease JME viscosity along with studying effects on diesel engines. It has been also used in a dual fuel engine with JME used as a pilot fuel and the main was gaseous fuel. In addition to testing (JME) combustion in indirect injection diesel engines, the solid residue remaining after extraction of the oil from jojoba seeds has been also used as a fuel for furnaces. It has been concluded that (JME) can be safely used as an alternate fuel in diesel engines with the possibility of decreasing its high viscosity to within the acceptable limits related to diesel engines fuels. However, it has been found that there is no study about the conversion of jojoba oil–wax to biofuel using ethanol (jojoba ethyl ester) and also its properties when mixed with pure ethanol are missing. So the possibility of using jojoba ethyl ester on one side, and its blends with ethanol on the other side in diesel engines, through studying the physical and chemical properties of the jojoba ethyl ester and its blends with ethanol in different ratios (5%, 10%, 15% and 20% ethanol by volume)[5].

The transportation sector worldwide is almost entirely dependent on petroleum-derived fuels while petroleum-based products are one of the main causes of anthropogenic carbon dioxide (CO2) emissions to the atmosphere. One-fifth of global CO2 emissions are created by the transport sector, which accounts for some 60% of global oil consumption. More than 95% of biodiesel production feedstock's come from edible oils. Although they are mainly produced in many regions; it may cause some problems such as the competition with the edible oil market, which increases both the cost of edible oils and biodiesel. Moreover, it will cause deforestation in some countries because more and more forests have been felled for plantation purposes. In order to overcome these disadvantages, many researchers are interested in non-edible oils which are not suitable for human consumption because of the presence of some toxic components in the oils. Furthermore, non edible oil crops can be grown in waste lands that are not suitable for food rops and the cost of cultivation is much lower because these crops can still sustain reasonably high yield without intensive care. The search for alternative fuels has lead researchers to investigate more sustainable sources such as, jojoba oils. This oil is rare in that is an extremely long (C26–C48) straight chain wax ester, making jojoba and its derivative jojoba esters more similar to sebum and whale oil than traditional vegetable oils. Pure jojoba oil has been also used and its blends with diesel fuel for diesel engines. This research is concerned with producing biodiesel from non edible oil (Egyptian jojoba oil). The choice of the Egyptian jojoba oil (GREEN GOLD) is due to its availability in Egypt, low prices, low chemical reactivity and very high boiling point (382°C) that gives this product very important physico-chemical properties and uses[6]. Jojoba oil appears to be a promising diesel fuel with promising scope for cultivation in the relatively hot weather. The chemical structure of Jojoba oil is similar to sperm oil which has been used as a constituent in many lubricating oil formulations. In the automotive industry, Jojoba oil is a superior lubricant in high speed machinery, tool work, and metal cutting. It requires no refining yet will cause a car to run cooler when added to the crankcase oil. Jojoba oil is also monoviscous. Because of this quality, jojoba oil significantly reduces friction. It can be used as a substitute to engine lubricating oils. Radwan et al prepared JME by using 4.6 mole of methyl alcohol per mole of raw oil. Experimentally the first use of pure jojoba methyl ester and its blends with gas oil in an indirect injection diesel engine equipped with performance, combustion pressure and peak rate of pressure rise measurements; the later factor is of direct effect on engine operational roughness, combustion noise and vibration. The engine test variables included the percentage of jojoba methyl ester in the blend, engine speed, load, injection timing and engine compression ratio [7,8].

The unique chemical structure of jojoba oil, on the contrary, contributes to good stability and miscibility in mineral oil base stocks. The studies carried out on the utilization of jojoba oil as a component or additive in lubricant formulations [9]. The main objective of the present work is to determine the kinetics of Jojoba oil methanolysis using a heterogeneous catalyst derived from fish industry. The mathematical model to obtain the kinetic parameters is a multiparametric non-linear regression based on the Marquardt algorithm. Calculations were performed using experimental data obtained at different temperatures, catalysts contents and methanol:oil ratios[10,11]. The feasibility of the commercial use of jojoba methyl ester as biodiesel is strongly dependant on the added value obtained for the fatty alcohols produced as secondary product in the transesterification process. The present work evaluates the different variables affecting the alkaline methanolysis of jojoba oil. The optimum values for the variables affecting the process were determined by application of Factorial Design and Response Surface Methodology. Factorial design of experiments provides more

information per experiment than unplanned approaches; it allows to evaluate interactions among experimental variables within the range studied, leading to better knowledge of the process and therefore reducing research time and costs [12, 13].

Before BD–JO or PD–JO blends being used in engine or in liquid fuel heating devices, it is necessary to know the physicochemical properties of these fuels as compared to standard PD before using them in engine and in liquid fuel burning systems. In this work, viscosities and densities of (JO + BD) and (JO + PD) mixtures are measured and correlated over the temperature interval (293.15–353.15 K). The flash points and heating values of the blends are investigated[13]. The antioxidantant lipoxygenase inhibition activities of the phenolic compounds isolated from the leaves extracts of S. chinensis, and to provide evidence for the utilization of S. chinensis leaves as a rich bioactive source of natural antioxidants[14,15]. The impact of hydrodesulfurization on lubricity and low temperature properties of petrodiesel was significant due to reduced sulfur content as well as nitrogen, oxygen, olefinic content, and aromatic content of ultra-low sulfur diesel (ULSD, S<15 ppm). Therefore, to understand the effect of JME on lubricity and low temperature properties of ULSD, blends of JME in ULSD at 5 vol.% (B5) and 20 vol.% (B20) were prepared and evaluated and compared to the corresponding blends of SME in ULSD and relevant petrodiesel standards.[16]

II. METHOD & MATERIAL

Mazloom Shah et. al. obtained Jojoba seeds from oil seeds program of National Agricultural Research Center, Islamabad, Pakistan. The chemicals used for the synthesis, physicochemical characterization of biodiesel and for the synthesis of catalysts were methanol (CH3OH), sodium hydroxide (NaOH), potassium hydroxide (KOH), sodium sulfate (Na2SO4), isopropyl alcohol (C3H7OH) and acetic acid (CH3COOH). The oil was heated on a hot plate to remove moisture before reaction. Two methods were adopted for the synthesis of biodiesel. In first method NaOH or KOH were used as catalyst. The sodium or potassium methoxide was prepared by dissolving 6.5 g NaOH or KOH in 200 mL methanol in separate beakers and stirred for half an hour. The resultant methoxide solution was put into one liter of vegetable oil, the mixture was heated at 60^0C and with stirring for 60 min at 500 rpm. The reaction mixture was cooled to room temperature and allowed to settle down, resulting in the separation of two phases. The upper phase contained biodiesel and the lower phase contained glycerin byproduct, which were separated by simple decantation. The biodiesel layer also contains the excess methanol, remaining catalyst, soap formed and partly reacted glycerides. After separation biodiesel was purified by distilling the residual methanol at 60 ^{0}C. The remaining catalyst was removed by successive washing with distilled water at pH 4.5 by adding 1–2 drops of acetic acid. Anhydrous Na2SO4 was then added to remove water followed by filtration. For the second method, experimental conditions were adjusted using different tin compounds as catalysts. The transesterification reactions were conducted at various oil methanol ratios of 1:5, 1:7, 1:9, 1:11, 1:13, 1:15, 1:17, 1:19, 1:21, 1:23, 1:25, 1:27, 1:33 and 1:43, the catalyst concentrations were 0.5, 1.0, 1.5 and 2.0 % of oil whereas the temperatures were ranged from 50 to 90 ^{0}C at an interval of 10

^{0}C. The product formed was washed three times with distilled water. Anhydrous Na2SO4 was added to remove water followed by filtration[1]. The biodiesel yield was calculated by using the expression:

$$\%\ \text{Biodiesel Yield} = \frac{\text{Amount of methyl ester produced}}{\text{Amount of oil used for production}} \times 100$$

The jojoba oil used by Mohamad et. al. was commercially produced in a local company called FABICO located in Amman, Jordan. About 20 gallons of jojoba oil were bought into the lab and were used as an engine fuel in pure form (100% jojoba oil), as well as a 50-50 blend with local diesel (B50)[2].

The jojoba seeds used by C. Palla et. al. for the experiments were cultured and harvested in La Rioja (Argentina). Experimental extractions of jojoba oil from milled seeds were carried out using CO2/propane solvent mixtures. The influence of the solvent composition and the phase behavior on the extraction rate was analyzed. The solubility of jojoba oil in CO2/propane mixtures at 313 K and different pressures was also determined from the experimental data in the study. Special attention was given to the effect of heat pre-treatment and grinding size of the oil seeds, which have proved to influence the performance of the extraction process. Different amounts of jojoba oil seed were processed in order to determine the solvent load capacity according to the CO2concentration in the solvent mixture. Additionally, a differential mass transfer model was used to fit the experimental data and to analyze the performance of the extractions. The solute molar mass (equal to 616.5 g/mol) was estimated from the fatty acid composition of jojoba oil, and the solute critical volume (equal to 2337.5 cm3/mol)was calculated with Joback method[3]

JO transesterification using different alcohols was conducted by the method suggested by Noureddin et al. JO was supplied by Jojoba Israel (Israel). The reaction was conducted using excess alcohol, i.e., molar ratio of alcohol to oil of 6:1 and catalyst concentration of 1.5%. The molecular weight of Jojoba oil is 657 g/mol. Potassium methoxide was dissolved in alcohol, which was added to hot oil and the reaction was carried out in batch stirred reactor of 5 L with temperature is lower than boiling point of each alcohols. To avoid the emulsion formation after the transesterification reaction, 0.1% aqueous hydrochloric acid was used as a washing solution to remove catalyst. With mild agitation in the reactor, the alcohol, catalyst and most of the soap could be removed by three washes. The complete removal of the catalyst was checked by bromophenol blue indicator. Traces of moisture and unreacted alcohol were eliminated by vacuum distillation. After the washing process, it was observed that the separation of water from ethyl, propyl and butyl esters takes longer time in comparison with methyl ester [4]. It can be seen that the raw jojoba oil has very high viscosity of 24.5 mm^2/s (compared

to 7 mm^2/s for conventional diesel). Ahmad et. al. used Ethanol (CH3CH2OH) to produce the jojoba ethyl ester with adding some of sodium hydroxide (NaOH) as catalyst. The conditions for the reaction were as follows: heating time of 60 min, reaction temperature of 60 ^{0}C, stirrer speed of 600 rpm, and the reaction was quenched by adding 40% by volume cold water at temperature of 5–8 ^{0}C. Several transesterification processes have been done to optimize the amount of ethanol for the maximum yield of methyl esters. For 100 ml of raw jojoba oil, the amount of ethanol has been decreased from 10% to 4% and it is mixed with 1% NaOH of oil weight for 5–8 min. After the mixing is finished, transesterification reaction is quenched with adding some water by 40% volume of mixture, allowing for 24 h to stabilize. It has been noticed that upon using (10% ethanol), (9% ethanol), (8% ethanol), and (7% ethanol by volume), the proportion of jojoba ethyl ester extracted is respectively: (94% JEE), (94% JEE), (93% JEE), (91% JEE by volume). Upon using (6% ethanol) the process did not complete, i.e. a proportion of oil remains untransesterificated. Upon using (5% ethanol) and (4% ethanol), glycerol is not separated completely, and the residue is oil, ester, and a very little proportion of glycerol [5].

M.Abdel et.al. used egyptian Jojoba oil (green gold) which supplied by Egyptian Natural Oil Company. Jojoba seed can yield up to 60% pure oil. In a one liter 3-neck round bottom flask, 100 ml of Egyptian Jojoba oil were heated and stirred in a water bath equipped with magnetic stirrer (Wisdstir, temperature range up to 400 °C & stirring range up to 1700 rpm) to the required temperature (20 - 65 °C) at 1000 rpm. KOH in the ratio (0.3 -2 %by weight of oil) was added to methanol (3:1-10:1 molar ratio to oil) in a separate flask and carefully shake till KOH became completely soluble in methanol (methoxide is formed). Methoxide was added to the heated oil. The product was left in a separating funnel for 12 hours and then the ester layer was collected after complete separation by washing with hot water for 5-6 times and using anhydrous Na2SO4 for drying. The yield was determined by measuring the volume of ester layer (biodiesel) and the conversion was determined using gas chromatography and quadruple Mass Spectrometers [GC-MS][6].

M.Y.E. Selim et. al. obsereved jojoba oil as a promising diesel fuel with promising scope for cultivation in the relatively hot weather. Tests have been carried out for pure diesel and pure JME to check the cyclic variability of maximum pressure and maximum pressure rise rate[7]. Patrick et al. collected Jojoba cuttings from plantations that were established 16-20 years ago and had been abandoned for several years. The plantation location is at Las Cardas Experimental Station ($30^0$13’ S, $71^0$15’ W, 260 m above sea level). Methyl esters were prepared by reacting the extracted jojoba oil with methanolic sodium methoxide and extracting the esters and alcohols from the aqueous phase with hexane[8].

S.M. Palash et.al. proposed many possible reasons for the increase of NOx emissions when biodiesel is used in diesel engine. On the other hand few of them also found reduced NOx emissions using biodiesel fuels. They have also proposed other mechanisms. No single factor is responsible for these NOx effects. The higher cetane number of biodiesel implies shorter ignition delay which reduces the combustion temperature as well as residence time, consequently less NOx formation[9,10]. Marcos et. al. used jojoba oil is supplied by Jojoba Israel (Israel). Certified methanol of 99.8% purity is supplied by COR (Madrid, Spain). GC standards were supplied by Sigma Aldrich. The catalyst is produced by the calcination of mussel shells (Mytilus galloprovincialis specie) from Galicia (Spain). For obtaining the kinetic modeling of the transesterification of Jojoba oil using a waste from the fish industry experiments were conducted. In addition, the influences of the temperature ,catalyst percent and the methanol:Jojoba oil ratio were determined. The transesterification of Jojoba oil using a waste from fish industry was carried out at different operation conditions where the variables have been the temperature, the catalyst concentration and the methanol:oil ratio. The catalyst was synthesized by calcination at 800 ^{0}C of M. galloprovincialis shells and it was completely characterized. The temperature, the methanol:oil ratio and the catalyst percent have a positive effect on the reaction yield. However, there are opposing effects at high methanol:oil ratios and catalyst percentages which affect the transesterification yield[11].

A. Bouaid et.al. used methanol of 99.8% purity was supplied by Panreac (Spain). The catalyst used was potassium hydroxide purchased from Panreac (Spain). Jojoba oil was added to the reactor and fitted with a reflux condenser. When the set temperature was reached the catalyst, diluted in methanol, was introduced in the reactor. Samples were taken at regular intervals and analyzed by gas chromatography. The total reaction time was 60 min. Throughout the experiments, the pressure and impeller speed remained constant. The ester yield generally increases with increasing catalyst concentration and temperature, but it is progressively decreasing at high levels of these factors [12]. Zayed et. al. used Jojoba oil which is extracted from jojoba seeds with hexane as solvent using Soxhlet extractor. Petroleum PD is bought from normal fuel tanking station. The kinematics viscosity of JO is much higher than the ASTM and EN values. On the other hand, the AV and IV of jojoba oil are within the given standard. The kinematics viscosity of the BD produced in their study is within the ASTM specification range but it is approximately 17.2% higher than the maximum viscosity specified for biodiesel according to EN 14214 standards. Nevertheless, the values are higher than the PD specifications. Moreover, the AV and IV are lower than the standard ASTM and EN values. The specific gravity (SG) in BD standards, according to the EN14214, has been determined as 0.860–0.890. The water content of the produced BD (0.053 wt%) is very close to the standard BD values (<0.05 wt%)[13].

Conventional Internal Combustion Engines can be operated with bio-diesel without major modification. In comparison to diesel, the higher cetane number of bio-diesel results in shorter ignition delay and longer combustion duration and hence results in low particulate emissions and minimum carbon deposits on injector nozzles. It is reported that if an engine is operated on bio-diesel for a long time, the injection timing may be required to be readjusted for achieving better thermal efficiency. Various blends of bio-diesel with diesel have been tried, but B-20 (20% bio-diesel + 80% diesel) has been found to be the most approximate blend. Further studies

have revealed that bio-diesel blends lead to a reduction in smoke opacity, and emissions of particulates, unburnt HCS, CO2 and CO, but cause slightly increase in nitrogen oxides emission[14,15,16]

Shailesh et. al. purchased PNJ Golden JO without commercial additives from Purcell Jojoba International (Lake Havasu City, AZ, USA) and used after acid-catalyzed pretreatment (APT). Refined, bleached, and deodorized (RBD) SO without commercial additives was purchased from KIC Chemicals (New Platz, NY, USA) and used as received. BD prepared with oil having higher AV (i.e., presence of free fatty acid) and base catalyst lead to soap formations and, consequently, increase in the formation of emulsions; this impacts on the yield of BD[15,16]. Moreover, such BD also influence on certain physical properties of fuel. In order to overcome the above-mentioned short-falls, acid-catalyzed pretreatment of jojoba oil (APT-JO) was carried out as discussed below. APT-JO was accomplished in a 1,000-mL three-necked round-bottom flask connected to a reflux condenser and a mechanical magnetic stirrer set to 1,200 rpm. Initially, JO (431 g, 500 mL, 0.732 mol) and methanol (175 mL, 5.47 mol) were added to the flask, followed by drop-wise addition of sulfuric acid (concentrated, 5 mL, 0.05 mol). The contents were then heated at reflux for 2 h. Upon cooling to room temperature (RT), the alcoholic phase was removed by gravity separation utilizing a separatory funnel. To remove residual methanol, the oil phase was washed with 5% sodium bicarbonate solution (three times) and distilled water (3×100 ml) followed by rotary evaporation under reduced pressure. Finally, treatment with magnesium sulfate (MgSO4) yielded dried and pretreated JO (427.4 g, 99.2 wt.%). Transesterification of APT-JO with methanol was accomplished. Freshly cut sodium metal (0.736 g, 0.032 mol) was added to the methyl alcohol (39.5 g, 1.23 mol) and allowed to dissolve for 30 min. The methoxide solution was then poured over a mixture of JO (172.4 g, 0.293 mol) and methyl alcohol (78.7 g, 2.46 mol) and the mixture was heated at 65°C for 4 h with stirring (600 rpm) at reflux. Upon cooling to RT, the reaction mixture was neutralized with a drop-wise addition of concentrated HCl (2.8 ml, 0.032 mol) while stirring. The excess alcohol was removed by rotary evaporation and the crude mixture was dried with sodium sulfate and filtered to yield a mixture of jojoba oil methyl ester (JME) and jojobyl alcohol (JA). The mixture of JME and JA (43 g combined, 50 ml) was dissolved in petroleum ether (100 ml; boiling point=30–60°C) and the solution was allowed to sit overnight (16 h) at approximately −15°C in a freezer. The solid JA was rapidly removed by a simple vacuum filtration apparatus. This procedure was repeated until no precipitate was noticed in the sample after 16 h at −15°C. The petroleum ether was then removed by rotary evaporation to afford purified JME[18,19].

III. CONCLUSION

The results and discussion may be combined into a common section or obtainable separately. They may also be

Biodiesel was synthesized from jojoba oil by transesterification of various base catalysts with methanol. The maximum yield of biodiesel was achieved through methanolysis of crude oil of these species at 1:23 M ratio of oil and methanol at 60 ^{0}C. The determined physical and fuel properties of the synthesized biodiesel were found to be comparable to ASTM standards for diesels. The FT-IR and NMR (1H and 13C) analyses of oil and biodiesel were performed which confirmed the formation of biodiesel. It may be concluded that jojoba as a wild desert shrub holds a genuine merit as a possible source of alternative, renewable energy. As such, jojoba is worthy of extra exploitation and a more scrutinized study to evaluate its potential to the fullest possible extent. Jojoba oil can serve as a supplemental fuel on its own or as blend with diesel fuel in compression-ignition engines. Jojoba ethyl ester and its blend with ethanol are considered as a good biofuel, which can be used in diesel engines. Using (7% ethanol) gives the maximum yield ratio of jojoba ethyl ester, taking into account the cost. The low calorific value of JEE/ethanol blend is decreased with increasing the proportion of ethanol in the mixture. The production of biodiesel from Egyptian jojoba oil by transesterification with methanol in presence of an alkaline catalyst (KOH) is affected by reaction time, methanol: oil molar ratio, catalyst concentration and temperature. The best yield percentage was obtained using a methanol: oil molar ratio of 6:1, KOH as catalyst (0.5%) and 60 ± 1 ºC temperature for 3 h at 1000 rpm. The yield of biodiesel was determined according to GC-MS. We can conclude that the non-edible oil (jojoba oil) can be used as a source for production of biodiesel fuel. The quality of bio-diesel is most important for engine part of view and various standards need to be specify to check the quality. As per the analytical method high performance liquid chromatography method is suitable to analyze the reaction intermediates and products of transesterification reaction.

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