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Production Of Biodiesel From A Novel Source

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Abstract

We have been depending on fossil fuels over the past decades. The existing sources of fossil fuels are going to last for another hundred years or so. The energy requirements of the world are increasing day by day and the demand has been running ahead of supply. Therefore scientists all over the world are pondering in search of new sources of energy. Growing concern over the threat of global changes has led to an increased interest in research and development of renewable energy technology. Biodiesel is an alternate fuel for conventional fossil fuels. The present study aimed at the preparation and evaluation of biodiesel from oil extracted from Artabotrys odoratissimus. The FTIR results confirmed the presence of methyl and ester group in the produced biodiesel.

Keywords: Artabotrys odoratissimus fruit oil, Biodiesel, FTIR, soxhlet extraction, Transesterification.

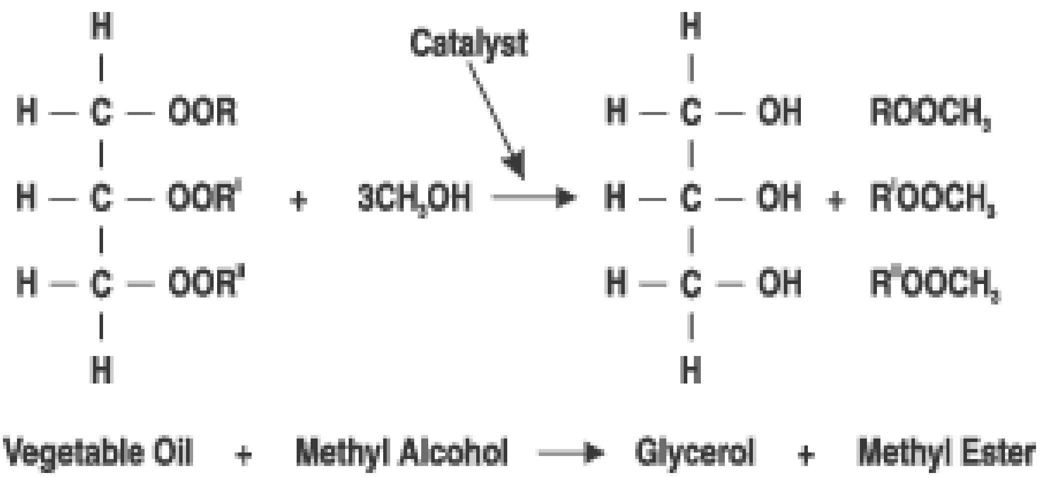
Introduction

Biodiesel has gained importance in the recent past for its ability to replace fossil fuels which are likely to run out within a century. Biodiesel offers an alternative fuel that is technically and environmentally acceptable and economically competitive. About 99% yield was obtained when methyl ether Trans-esterification of Grape seed oil was done in 2 steps[1]. With potassium methoxide when used as a catalyst, an yield of

98.46 weight percent was obtained and that of 99.33 weight percent with sodium methoxide[2]. Maximum yield of 91.3%, 90%, 92.7% were obtained from crude oils of Jatropha, karanj and sunflower oil respectively, when the reaction was carried out for 12 hours at 50^0c[3].The final conversion ratio of fatty acid methyl ester (FAME) from plant oil and waste oil was 93% and 92% respectively under optimal conditions when candida species was employed[4]. With the use of polanga seed oil (calophyllum inophyllum), 100% biodiesel was found to be the best which improved the thermal efficiency of the engine by 0.1%[5]. The methyl ester yield of crude Jatropha L. Seed oil (CJCO) was only 55% due to co-existence of free fatty acids (FFA) in the oil. But, 90% methyl ester yield with alkali base catalysed trans-esterification process was obtained[6]. 97% fatty acid methyl ester (FAME) yield was obtained with a reaction time of 12 hours and when the reaction time reached, 24 hours, the yield increased to about 99%.the filtrate was a mixture of FAME and diesel oil at a ratio of 45:55[7]. An 100% yield of ester was obtained using super critical methanol within 4 minutes only, at a temperature of 593k, under a pressure of 8.4 m pa,the molar ratio of methanol to oil was 43:1[8].With the employment of rapeseed soap stock, an yield of 96.45% was obtained. When optimum conditions of catalysed biodiesel production were used and about 98% yield when KOH was used as a catalyst[9]. In the presence of egg shell sample, calcined above 800^0c, 97-99% yield was obtained. When the calcination temperature was reduced to 700^0c, the yield was just 90%[10]. The yield of methyl ester from karanja oil under the optimal conditions was 97-98% when agitated at 1000 rpm and reaction temperature set below 60^0C [11]. About 99.3% yield was obtained when KF/MgO was used as catalyst under an optimal loading ratio of KF/MgO to 0.7[12]. For the vitia folia seed oil (TNSO) the methyl esters were 98.5% esterified While the ethyl esters were 97.5%[13]. For the reaction time of 60 minutes the ester formation was around 98%[14]. The Jatropha plant seed yield ranges from 7.5 to 12 tonnes per hectare per year, after 5 years of growth. The capacity of pilot biodiesel plant is 250 litres/day[15]. About 98% fatty acid methyl esters yield was obtained when corn oil was pumped in a co_2 stream at a rate of 4 ul/minute and methanol at 5 ul/minute[16]. The average yield of sun dried mauha seeds is about 1.6 kg/tree[17]. The in expensive feed stock from restaurant waste lipids represent one third of the US total fats and oil production[18]. Biodiesel yield per hectare was about 80% of the yield of the parent crop oil from microalgae[19]. Above 90% yield was obtained with waste cooking oil using stepwise addition of methanol[20]. The yield percentage obtained from waste vegetable oil was comparable to that obtained from neat vegetable oil which reached 96.15% under optimum conditions [21]. A high yield of methyl esters was produced using a packed bed reactor and lipase produced from R.oryzae cells immobilized with biomass support particles[22]. 1 ton of biodiesel was produced from 1.14 tonnes of crude palm oil (CPO)[23]. The yield of biodiesel was 97% when the 3 step addition of methanol was employed[24]. 99.5% biodiesel yield was acquired under optimum conditions from waste sunflower cooking oil[25]. A fungal bio catalyst grown and reacted at room temperature, converted almost 100% of combined glycerides into biodiesel, FFA and glycerine [26]. The combined increase of compression ratio, injection pressure, retarding injection resulted in lower emissions of NO_x as compared to the diesel fuel[27]. A conversion efficiency of 92.5% was obtained with the optimized reaction conditions with prinnakka oil[28]. In this research work, the process of biodiesel production in a pilot plant was studied using Artabotrys odoratissimus fruit oil as raw material, methanol as the solvent and sodium hydroxide as catalyst. The biodiesel quality was determined by FTIR method. The method showed that the final product had ester compositions which can be used as a biodiesel fuel in diesel engine. Artabotrys odoratissimus is an ornamental plant[29], Fruits of this plant are recorded as containing fixed and volatile oil glycosides and resins, extracts are reported to exhibit hypertensive and spasmogenic as well as cardiac stimulating effects on some animals and cardiac depressant on others[30] (Connolly et al., 1994). The essential oil of A. odoratissimus has shown excellent to good anti-helmintic property against tape worms, earth worms and round worms. Its flowers are used in the treatment of vomiting, biliousness, blood and heart diseases, itching, sweating, foul breath, thirst and headache [31](Sidhiqui et al.,1990). However, there exists no report on the use of Artabotrys odoratissimus seed oil in biodiesel preparation. The present study aimed at the preparation and evaluation of biodiesel from Artabotrys odoratissimus seed oil by transesterification. The transesterification reaction was base catalyzed. Any strong base capable of deprotonating tht alcohol will do it. (e.g. NaOH, KOH, Sodium methoxide, etc.). Commonly the base (KOH, NaOH) is dissolved in the alcohol to make a convenient method of dispersing the otherwise solid catalyst into the oil. The ROH needs to be very dry. Any water in the process promotes the saponification reaction, thereby producing salts of fatty acids (soaps) and consuming the base, and thus inhibits the transesterification reaction. Once the alcohol mixture is made, it is added to the triglyceride. The reaction that follows replaces the alkyl group on the triglyceride in a series of steps. The carbon on the ester of the triglyceride has a slight positive charge, and the carbonyl oxygen's have a slight negative charge. This polarization of the C=O bond is what attracts the RO^- to the reaction site.

Transesterification

A reaction scheme for transesterification is as follow



Factors Effecting Transesterification Reaction:
Moisture And Free Fatty Acid:
The glyceride should have an acid value less than 1 and all material should be substantially anhydrous. If the acid value was greater than 1, more NaOH was required to neutralize the free fatty acids. Water also caused soap formation.

Catalyst
Catalysts are classified as alkali, acid, or enzyme. Alkali catalyzed reaction is much faster than acid catalyzed reaction is much faster than enzyme catalyzed reaction. However if a glyceride has higher free fatty acid content and more water, acid catalyzed transesterification reaction is suitable.

Molar Ratio
One of the most important variable effecting the yield of ester is the molar ratio of alcohol to triglyceride. The stoichiometric ratio of transesterification requires three moles of alcohol and three moles of glyceride to yield three moles of fatty acid ester and one mole of glycerol the molar ratio is associated with type of catalyst used Base catalyzed transesterification is best suitable method for lab scale as well as industrial scale production of biodiesel because it consumes less time and high production efficiency etc.

MATERIALS & METHODS
Materials
The fruits of Artabotrys odoratissimus were collected from the garden of the Andhra University. Sodium hydroxide and solvents used were purchased from Merck Specialties Private Ltd, India

Extraction of Artabotrys odoratissimus fruit Oil
The dried kernels were finely powdered and the powder (500 g) was Soxhlet extracted using hexane (2,000 ml) as the solvent for 8 h. After 8 h, the solvent was removed using a rotary evaporator and dried under reduced pressure to obtain Artabotrys odoratissimus oil (160 g, 32%yield).

Soxhlet extractor used for extraction of oil

Biodiesel preparation from Artabotrys odoratissimus Fruit oil

Artabotrys odoratissimus fruit oil (280 g) was taken in a two-necked round-bottom flask equipped with an overhead mechanical stirrer and a refluxing condenser. To this, a solution of 4.07 g sodium hydroxide (1.5 wt% of the oil) dissolved in 62.8 g(22.5 wt% of oil) methanol was added. The contents were stirred for 60 min at 60 °C and the contents were transferred to a separating funnel to separate the glycerol layer (26 g). The upper layer consisting of the partially esterified product was collected and mixed again with a solution of 1.358 g sodium hydroxide (0.5 wt% of the oil) in 20 g (7 wt% of the oil) methanol and subjected to transesterification under the same reaction conditions described above to convert the unreacted acyl glycerols to biodiesel. The reaction product was put into a separating funnel and allowed to settle for 30 min to separate the glycerol layer (3 g). The glycerol layer was removed, the product thoroughly washed with water to remove traces of soap and glycerol and dried under reduced pressure to obtain biodiesel (265g).

Characterization of vegetable oil and biodiesel:

Fourier Transform Infrared Spectroscopy (FTIR) was carried out using PERKIN – ELMER instrument to identify the functional groups of biodiesel.

RESULTS AND DISCUSSION

Fourier Transform Infrared Spectroscopy (FTIR) Analysis:

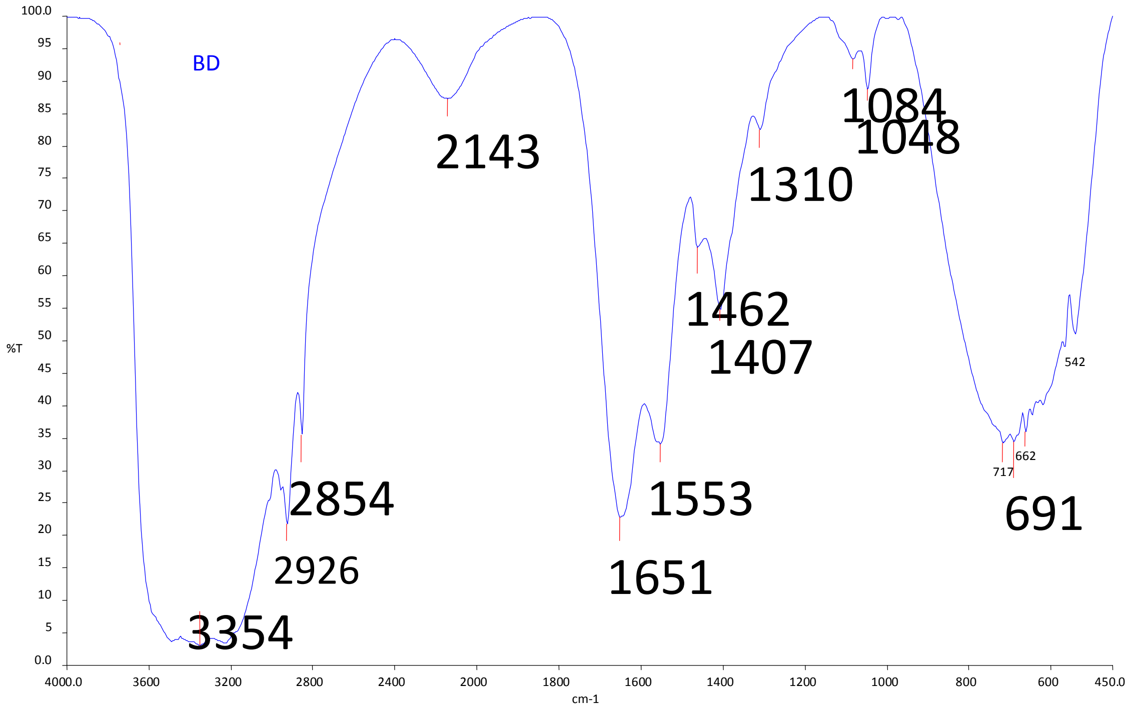


Figure - 1

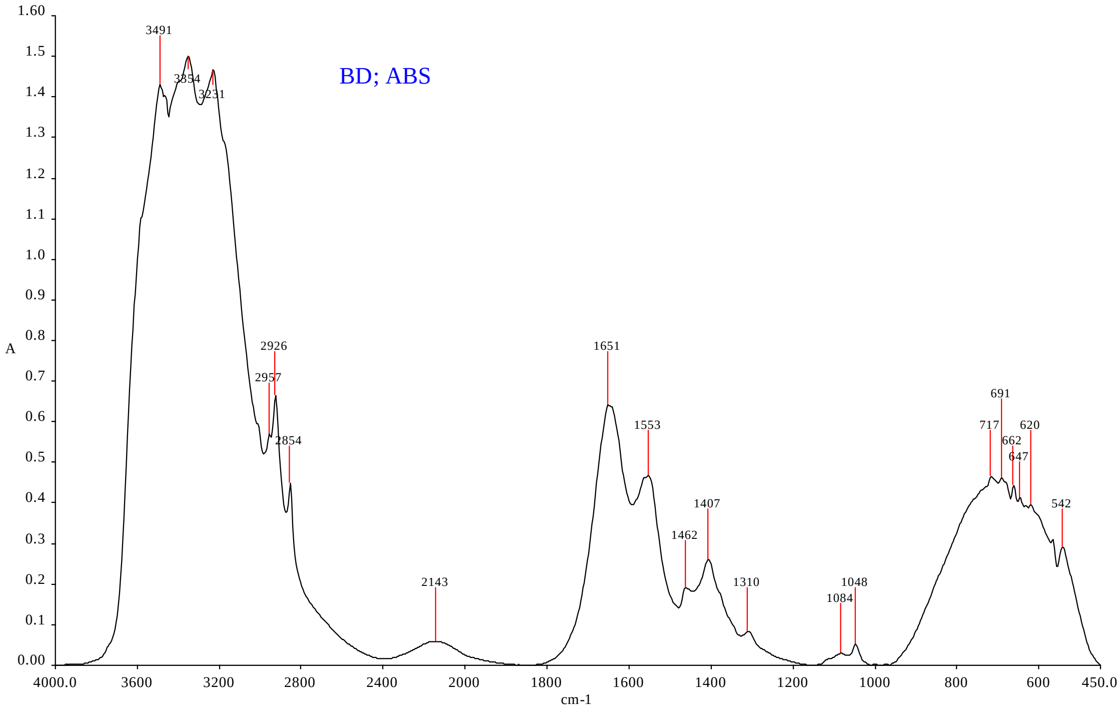


Figure.2. FT-IR Spectra for Artabotrys odoratissimus fruit oil

The O-H stretching of the hydroxyl bonded with alcohol found at 3354cm$^{-1,}$Alkanes strongly stretched at 2926,2854,1462 cm^{-1} Ester group strongly stretched found at 1651cm$^{-1,}$ The strong ester peakat 1651 (the C=O vibration) and at 1084 (C-O vibrations) are clear, and are the basis for the biodiesel properties. Similar peak was also observed by Yab et al[32]

The bands at 1407cm^{-1} indicate the presence of C-C stretching. The observed band at 1462 cm^{-1}for methyl group revealed the formation of biodiesel (Figure.1).

CONCLUSIONS

The production of biodiesel from Artabotrys odoratissimus seed oil with methanol was successfully conducted. Fourier Transform Infrared Spectroscopy (FTIR) Analysis confirms the functional groups in the biodiesel produced, So Artabotrys odoratissimus fruit oil is the cheap alternative for the production of biodiesel

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