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Synthesis of Rice Husk Nano-Particles for Biodiesel Production

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ABSTRACT

Biodiesel is an alternative fuel for diesel fuel, because of scarcity and crude oil prices researchers are focusing on this area. *Pongamia pinnata* (Karanja) is an oil bearing tree, which is non-edible feedstock and it is used for biodiesel production. Trans esterification process is used to produce biodiesel in the presence of methanol and KOH. Rice husk were pulverized and it was reduced to nanoparticles by using ball milling process. The prepared nanoparticles was also characterized by scanning electron microscope (SEM) and EDAX, and X-ray diffraction (XRD). EDAX study confirms the presence of the elements C, O, Mg, Si, and K in the rice husk. XRD consequence showed that grain size of the rice husk as 0.026nm.

KEY WORDS: Biodiesel, Nanoparticles, Pungamia, Rice husk, Trans esterification.

1. INTRODUCTION

The Rice husk is an agriculture residue which is chosen because of easily availability and less price or sometimes free-of-charge. The width of rice husk is 1 to 4mm and maximum length of rice husk is about 10mm. Rice husk is used to generate electricity because of their high calorific value. Rice husk is agro-industrial waste by-products from the rice hulling and it consists of 15–20% inorganic (SiO_2) and organic substances of cellulose 35%, hemicellulose 25%, lignin 20%, and ash 17% (silica 94%), by weight. It also consists of 3% of moisture by weight in raw rice husk and contains trace amount of metal ions. It has lower energy density and high ash content. Paddy contains 72% of maximum part of rice and 5-8% of bran and 20-22% of husk on average. Rice husk have a heating value of 16.3 MJ/kg, 74.0% volatile matter, and 12.8% ash. India has recommended two plant species, viz. jatropha (*Jatropha curcas*) and karanja (*Pungamia pinnata*) for bio-diesel production.

Karanja (pungamia) is an oil seed-bearing tree, which is non-edible. Diesel fuel is generally used for transportation, agricultural applications, industrial applications, commercial, and domestic purpose and for the generation of mechanical energy and to produce electricity. As an alternate to diesel fuel, biodiesel is used for generate mechanical energy as of eco-friendly. Biodiesel has lots of benefits that include biodegradable, low emissions, non-toxic and better lubricity. Biofuel is not commercially existing, because the production cost is higher than diesel and non-availability of raw material.

Biodiesel is a renewable energy which is produced from vegetable oils or animal fats this properties are similar to diesel fuel so this is alternative to diesel fuel. Biodiesel is not commercially existing, because of production cost is higher than diesel. The biodiesel cost is higher due to high quality of edible oils with contains low content of free fatty acid (FFA).

Several oil seed crops of non-edible feedstocks such as jatropha(Jatropha curcas) and karanj (*Pongamia pinnata*), neem, rubber seed (Heveabrasiliensis), mahua (Madhucaiondica), tobacco (Nicotianatabacum L.), jojoba, linseed, polanga, cotton seed, etc. non edible oils are used for biodiesel production without affecting food security. Edible oil such as Soybean, rapeseed, soybean, sunflower and palm oil, coconut oil, rapeseed oil, groundnut oil, canola, and corn etc. Present studies focused on non-edible oil of karanj (*Pongamia pinnata*).

2. MATERIALS AND METHODS

Rice Husk Nano Particles Preparation: The rice husk is used in the present analysis was obtained from local rice mills at Tiruchendur, Tamilnadu, India. The collected rice husk were washed with distilled water to remove grit and other impurities and dried for 24h. The dried material were then ground using a domestic mixer. The ground materials were then sieved to constant particle sizes of 80 mesh to remove the impurities. The obtained rice husk were then reduced as nanoparticles by using ball milling process.

Synthesis of rice husk nanoparticle: Rice husk Nano powder was mechanically prepared by using a planetary ball mill. At the beginning the rice husk is greater than 1 mm in size then rice husk powder may mechanically be reduced into the size range of less than 100 nm by the use of planetary ball milling. The rice husk nanoparticles are done by mean of a planetary ball mill (Fritsch, GmbH, ‘Pulverisette 6’ planetary mono mill). The milling time for rice husk was 5 hours with 5 min idle for each 15 min at rotational speed of 300rpm. Finally the ground powders was dried at atmospheric temperature and then this nanoparticles was blended with biodiesel.

Biodiesel: The step by step procedure for the production of biodiesel from Pungamia seed oil is shown in Fig. 1. In this process acid esterification was carried out for non-edible oil. In acid esterification sulfuric acid and methanol are mixed together and then trans esterification was carried out. This trans esterification process is used to reduce viscosity. Due to trans esterification glycerine and biodiesel was separated. Finally rice husk Nano particles was added with the obtained biodiesel.

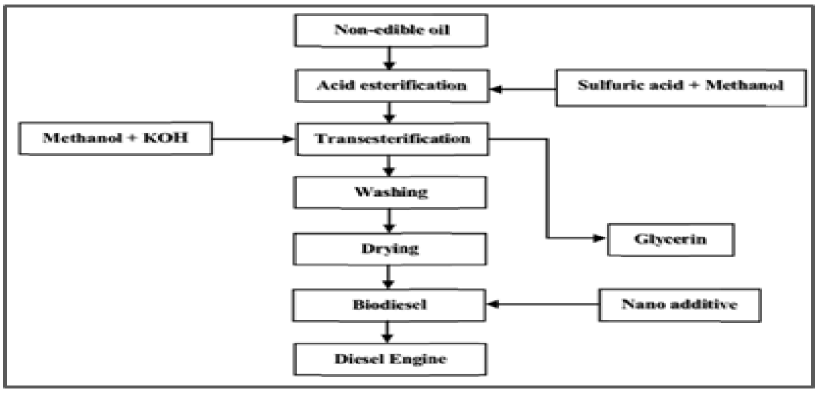

Fig.1. Process flow chart for Biodiesel Production

Scanning Electron Microscopy (SEM) and EDAX: The morphological characterization of the rice husk (RH) were carried out with a JEOL Model JSM 6390 Scanning Electron Microscope and coupled to Energy Dispersive X-ray Spectroscopy.

X-Ray Diffraction (XRD): Finely ground rice husk (RH) was used for X-ray diffraction studies. The samples was analysed through XRD 6000SHIMADZU model coupled with Cu Kα radiation was done to study the structure transformation of the rice husk nanoparticles.

Biodiesel production: In acid catalyzed esterification process 100ml of Pungamia seed oil was taken in a reactor flask and it was heated to 60^0C. 1ml of sulphuric acid (H_2SO_4) and 50ml of methanol was added with raw pungamia seed oil and it was heated for 2hours. After the reaction got completed the resultant product was taken and it will be separated to remove the excess alcohol.

In base catalyzed esterification 500 ml round bottom glass flask equipped with condenser and magnetic stirrer arrangement is used for the present analysis. An amount of 100ml Pungamia oil was transferred in to the round bottom flask and heated to 50^0C. Then, 30ml methanol and 0.5g KOH were added and stirrer at 300rpm with continuous temperature of 65^0C for 2h. After 2h of reaction the reaction mixture where cooled for 24h and the ester and glycerin were separated by using separating funnel. Finally, the biodiesel and glycerin layers were separated. The excess amount of methanol, catalyst and trace amount of glycerin was removed by hot distilled water washing.

3. RESULTS AND DISCUSSION

The Pungamia has high FFA and so straight alkali-catalyzed method is not suitable for biodiesel production. For producing the suitable quality biodiesel dual stage process of acid-catalyzed and followed by base-catalyzed esterification is made. As a result, the FFA value of Pungamia seed oil was reduced to a desired value. The FFA value of raw Pungamia seed oil is 4.95% and *Pungamia pinnata* methyl ester (PPME) is 0.56%. The biodiesel yield was observed as 85%. The percentage yield of *Pongamia pinnata* (Karanja) biodiesel has been calculated using the formula:

Biodiesel yield %, y= (grams of methyl ester produced) / (grams of oil used inreaction) × 100

A scanning electron microscope (SEM) was used to study the surface of rice husk and the internal structures of rice husk. The SEM image of rice husk was operating with 20kV and magnification of 1000X and it was represented in μm which was shown in the Fig 2. These image show that the rice husk nanoparticles are agglomerate on the surface and clusters of different shapes and sizes are produced. In this sample, the carbon particles present are maximum with gray colour and the size of carbon particles looks larger.

The SEM image shows numerous larger agglomerations of particles and this material has a less dense and homogeneous morphology. The presence of oxygen distributed in the carbon matrix is indicated by the presence of smaller particles with bright colour.

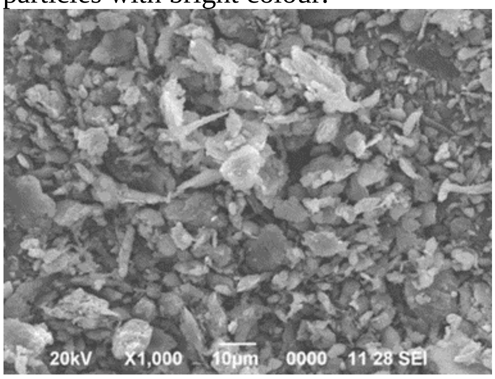

Fig.2. SEM image of rice husk (RH)

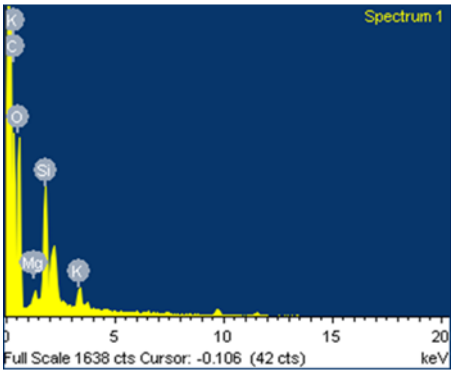

Fig.3. EDAX spectrum of rice husk

This EDAX studies is an additional confirmation by revealing the presence of high concentration of Carbon(C). The carbon concentration is 54.08% in weight basis with atomic proportion of 62.29%. The Oxygen (O) concentration is 40.81% in weight basis and 35.29% as atomic weight percentage. $CaCO_3$, SiO_2, MgO, K-MAD, MAD-10 Feldspar are used as the standards. In this rice husk nanoparticles, Carbon and oxygen existing as high concentration and Silicon (Si) presented as moderate amount of 3.80% by weight. But K and Mg are presented only as trace quantities of 0.92% and 0.39% in weight percentage.

The chemical compositional analysis for rice husk was carried out by using the energy dispersive analysis of X-ray (EDAX). EDAX spectrum of rice husk are shown in Fig. 3. From this figure, we can confirmed the presence of expected elements in the rice husk like C, O, Mg, Si, and K.From this XRD study, considering the peak at degrees, average particle size of prepared nanoparticles has been estimated by using Debye-Scherrer equation as follows:

$$D=0.9\lambda / \beta\cos\theta$$

Where, λ is the wave length of X-Ray (0.1540 nm), β is FWHM (full width at half maximum), θ is diffraction angle, d is d-spacing and D is particle diameter size. The particle size diameter was calculated as 0.026nm using Debye-Scherrer equation.

4. CONCLUSION

The present work determines that it is possible to prepare rice husk Nano particles using planetary ball mill. The trans esterification process was carried out for biodiesel production. The results found from the study shows that the nonedible oil of *Pongamia pinnata* (Karanja) which is promising feedstock for biodiesel production. According to this results morphological characterization were studied by SEM-EDAX and X Ray Diffraction (XRD).The presence of elements like C, O, Mg, Si, and K in the rice husk are confirmed using EDAX. From XRD study, average particle size of prepared nanoparticles has been estimated and the value is 0.026nm. The rice husk nano additive is highly eco-friendly and have higher calorific value. The biodiesel with rice husk nano additive will lead to improve combustion in diesel engine.

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