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SUITABILITY OF RICE BRAN OIL AS FEEDSTOCK FOR BIODIESEL MAKING

Abhinab Mishra[1*], Ghanshyam Tiwari[1], Abhay Kumar Mehta[1], Sudhakar Jindal[2]

[1]*Maharana Pratap University of Agriculture and Technology, College of Technology and Engineering, Department of Farm Machinery and Power Engineering, Udaipur, India*

[2]*Maharana Pratap University of Agriculture and Technology, College of Technology and Engineering, Department of Mechanical Engineering, Udaipur, India*

Abstract: India is second largest rice producing country and the estimated yield of crude rice bran oil (RBO) is about 400.000 tons of which only 50% is of edible grade, 50% of the total available rice bran oil is left unutilized due to presence of active lipase in bran and lack of economic stabilization methods most of the bran is used as animal feed or for industrial application. One of the best ways for the potential utilization of RBO is the production of biodiesel; also a very little research has been done to utilize this oil as a replacement for mineral diesel. In the present study, biodiesel has been prepared from Rice Bran oil by trans-esterification method meeting the acceptable quality standards and then used as fuel.

Key words*: rice bran oil, blend, trans-esterification, biodiesel*

INTRODUCTION

Energy is an essential requirement for economic and social development for any country but, with advent of industrial revolution and sky rocketing of petroleum fuel costs in present day has led to growing interest in alternative fuels which can be produced from locally available resources within the country such as alcohol, biodiesel, vegetable oils etc in order to provide a suitable substitute to diesel for a compression ignition (CI) engine [1, 5]. Presently the vegetable oils are the promising alternative fuel to diesel oil since they are renewable, biodegradable and clean burning fuel having similar properties as that of diesel.

[*] Corresponding author. E-mail: abhinab_mishra@yahoo.com

The most commonly used method to make vegetable oil suitable for use in CI engines is to convert it into biodiesel. Some of the vegetable oils like jatropha, karanj, sunflower, and castor are converted into biodiesel for a substitute to diesel for compression ignition (CI) engine but unavailability of these oils in plenty amount, rice bran oil may be one of the option. The estimated yield of crude rice bran oil (RBO) in our country is about 400.000 tons of which only 50% is of edible grade, 50% of the total available rice bran oil is left unutilized due to presence of active lipase in bran, which hydrolyses the triglyceride to fatty acids and glycerol, as a result the FFA content increases making difficult to refine, due to the presence of tightly associated wax [6]. Hence, the oil has to be de-waxed and degummed before being neutralized which lack economic stabilization. As a result most of the bran is used as animal feed or for industrial application. One of the best ways for the potential utilization of RBO is to extract Biodiesel from it; also a very little research has been done to utilize this oil as a replacement for mineral diesel.

MATERIAL AND METHODS

Filtration of crude oil

The crude rice bran oil was procured and various samples were prepared. The oil was filtered to remove the contaminants of oil to obtain a clear biodiesel. Due to excess viscosity and contaminants in the oil a filtration unit was made in which the oil was filtered from a filter cloth of 5 micron with a vacuum pump to obtain clear oil for the experiment (Fig.1).

Figure 1. Filtration unit

Determination of free fatty acid content

The clear filtered oil was further processed for esterification process for obtaining biodiesel. Before esterification process it is very important to determine the free fatty acid content of the oil. In order to determine the percent of FFA content in the oil,

chemical titration method was adopted as per manual of methods of analysis of foods, oils, and fats, Directorate General of health Services, Ministry of health and Family, GOI, New Delhi. 1 ml of rice bran oil in 10 ml of methanol was titrated with 0.1% NaOH solution (1 gram of NaOH in 1000 ml of water) using 4 - 5 drops of phenolphthalein as end point indicator till the color changes to light pink. The reading obtained were recorded and compared against standard values.

Trans-esterification process

After obtaining the FFA content in the oil from the above process, the sample was trans esterified as per standard rules i.e. if the oil contains more than 2% FFA, the FFA is reduced first by acid catalyst esterification method (using methanol in presence of sulphuric acid) and then alkali catalyzed method [7] (using methanol in presence KOH) esterification was done. After separation of glycerol, the ester was washed to remove un-reacted meth oxide. It was then heated to remove the water traces to obtain clear biodiesel. The rice bran methyl ester (biodiesel) thus obtained by this process was totally miscible with mineral diesel in any proportion. The process flow diagram for production of biodiesel is described in the Fig.2. [2-4]

Fuel properties

The fuel properties of Rice bran biodiesel and its blend were measured and tabulated in Tab. 1. Fuel properties of biodiesel and diesel were investigated for relative density at 31°C, kinematic viscosity in cSt, flash point (°C), calorific value ($MJ \cdot kg^{-1}$) and copper strip corrosion test at 50°C. The resulted fuel properties of biodiesel were compared with ASTM standards.

RESULTS AND DISCUSSION

Free fatty acids content of crude rice bran oil from titration was found to be >3.57 which was quite higher for preparation of biodiesel. Hence, Acid esterification and Alkali trans-esterification methods were followed which reduced the FFA content of Rice Bran Oil to 0.71%, which was quite low with permissible limit of 2%.

The relative density of crude rice bran oil was found to be 0.94. The values of relative density for diesel, RB biodiesel at room temperature were found to be 0.84, 0.88 respectively, while RB05 was observed to have density closer to diesel. This result confirms the findings of Mohanty (2013), who found similar results while producing biodiesel from rice bran oil [8].

The kinematic viscosity of crude rice bran oil was observed to be to be 48.4cSt at 31°C. The kinematic viscosity for diesel and RB biodiesel at room temperature were found to be 3.93 and 4.6 cSt respectively. Similar results were observed by K.C.Velappan (2007), when rice bran biodiesel and its five blends were fuelled to a CI engine [10]. The kinematic viscosity was very high for crude rice bran oil at ambient temperature but reduction in kinematic viscosity was observed after trans-esterification of the oil.

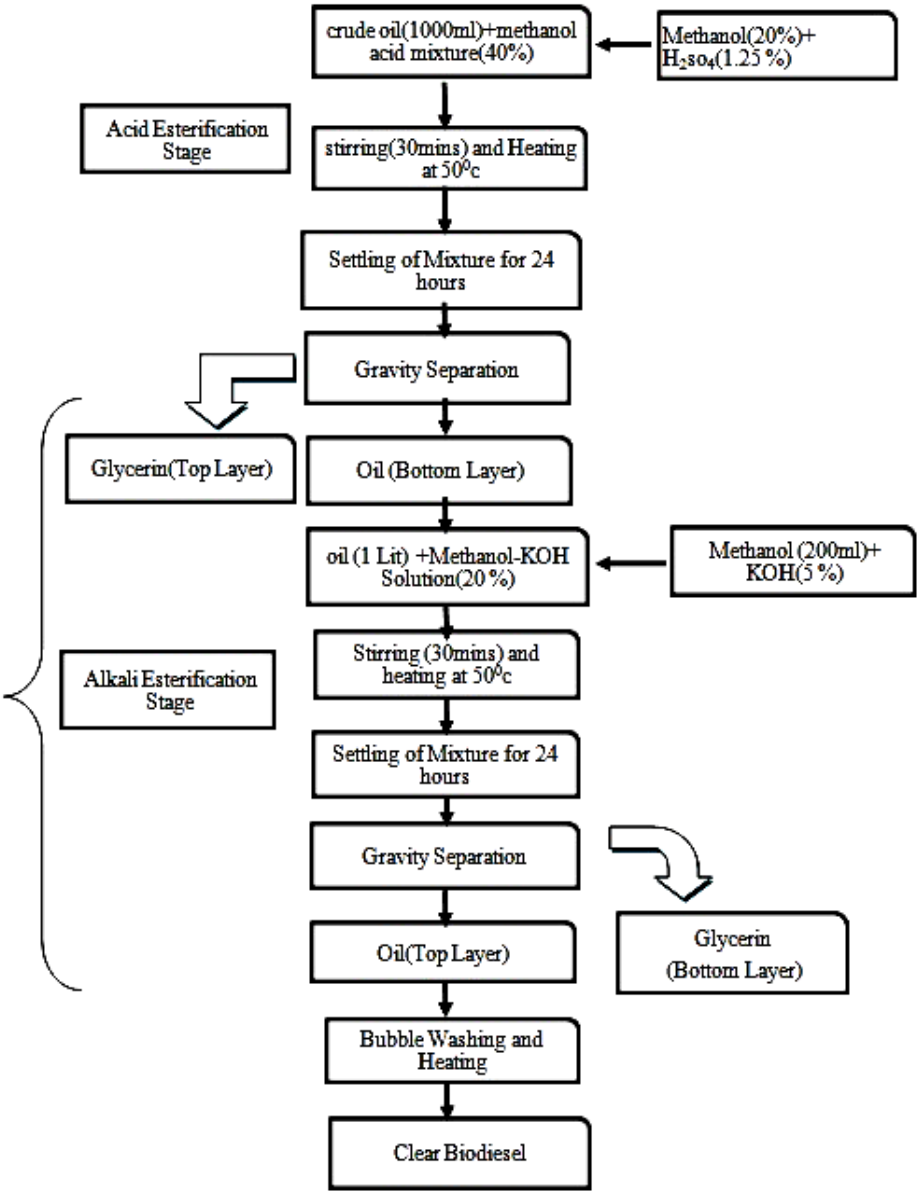

Figure 2. Process flow diagram for production of bio diesel

The calorific value for crude rice bran oil was found to be 41.36 $MJ \cdot kg^{-1}$ which is quite higher as compared to diesel. The difference in the calorific value of diesel and RB biodiesel may be attributed due to the difference in their chemical composition i.e. due to the difference in carbon and hydrogen content.

Flash point for rice bran oil was found to be 290°C, whereas trans-esterification of the oil marginally reduced the flash point temperature of the oil to 190°C. Although, higher flash point creates problem in self ignition in CI engines, but looking to the safe side of storage and handling of these biodiesels, higher flash point is more desirable.

The copper corrosion strip for evidence of tarnishing or corrosion was examined by comparing with the ASTM copper strip corrosion standards and the strip was found in transition state 1a (slight tarnish).i.e. light orange, almost same as freshly polished strip which indicates that the corrosion forming tendencies of fuel are less or equal to that of conventional diesel. Sanford *et.al*, (2009) prepared a feedstock and reported biodiesel characteristics for different crops and found similar results. [9]

Table 1. Properties of selected fuel compared with ASTM standards

S. No.	*Property*	*Unit*	*ASTM Methods*	*Rice bran iodiesel*	*Diesel*
1.	*Calorific value*	*[MJ·kg^{-1}]*	*D-4809*	*43.171*	*41.382*
2.	*Relative density at room temperature*	*[g·cm^{-3}]*	*D-1298*	*0.880*	*0.831*
3.	*Kinematic viscosity at 40°C*	*[cSt]*	*D-445*	*4.600*	*3.210*
4.	*Flash point*	*[°C]*	*D-93*	*190.000*	*76.000*
5.	*Copper strip corrosion test at 50°C*	-	*D-130*	*1A (slight tarnish)*	*1A*

CONCLUSIONS

The aim of this study was to evaluate rice bran oil as a potential raw material for biodiesel production. The biodiesel sample prepared in the present study showed better results and not deviating from ASTM standard. With the increasing demand for fuels, biodiesel can be a good substitute as it is a renewable source and can be a partial diesel substitute to boost the farm economy; reduce uncertainty of fuel availability by efficiently using it in small portable engines in rural areas for agricultural work and make fuel availability to the farmers and self-reliant. Also, this help in controlling air pollution to a great extent.

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POGODNOST ULJA PIRINČANIH MEKINJA KAO STOČNE HRANE ZA PROIZVODNJU BIODIZELA

Abhinab Mishra[1], Ghanshyam Tiwari[1], Abhay Kumar Mehta[1], Sudhakar Jindal[2]

[1]Maharana Pratap Univerzitet za poljoprivredu i tehnologiju, Fakultet za tehnologiju i inžinjerstvo, Institut za poljoprivredne i pogonske mašine, Udaipur, Indija
[2] Maharana Pratap Univerzitet za poljoprivredu i tehnologiju, Fakultet za tehnologiju i inžinjerstvo, Institut za mašinstvo, Udaipur, Indija

Sažetak: Indija je druga zemlja po proizvodnji pirinča, sa procenjenim prinosom ulja sirovih pirinčanih mekinja (RBO) od oko 400.000 t, od čega je samo 50% jestivo, a ostalih 50% ukupno raspoloživog ulja pirinčanih mekinja ostaje neupotrebljeno zbog prisustva aktivne lipaze u ljusci i nedostatka ekonomičnih metoda stabilizacije, pa se najveća količina ljuske koristi za stočnu hranu i industrijsku upotrebu. Jedan od najboljih načina za potencijalnu upotrebu RBO je proizvodnja biodizela; takođe, veoma malo istraživanja je izvedeno na upotrebi ovog ulja kao zamene za mineralni dizel. U ovom istraživanju biodizel je pripreman od ulja pirinčanih mekinja trans-esterifikacijom, čime je dobijen prihvatljiv kvalitet prema važećim standardima, a koji je kasnije upotrebljen kao gorivo.

Ključne reči: *ulje pirinčanih mekinja, smesa, trans-esterifikacija, biodizel*

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