One-pot synthesis of biodiesel from high fatty acid *Jatropha curcas* oil using bio-based basic ionic liquid as a catalyst

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This article describes a facile one-pot synthesis of biodiesel from non-treated *Jatropha* oil (*J* oil) with high acid value (ca. 17 mg KOH/g). Choline hydroxide exhibited superior catalytic activity than choline imidazole in the transesterification that yields 95 ± 1% of biodiesel, when the reaction was carried out with 9 : 1 molar ratio of methanol to *J* oil and 4 wt% catalysts at 60°C for 4 h. Further study showed that the catalyst exhibited almost constant activity for four successive trials after being recycled. The main fuel properties of the final product meets the ASTM standards. Moreover, the properties of biodiesel are identical to that obtained by conventional method (US 7,666,234 B2) and can be used as fuel in the existing diesel engines without any modification.

Keywords: Biodiesel, *Jatropha curcus*, ionic liquid, transesterification.

BIODIESEL is an attractive and alternative fuel synthesized from renewable sources[1,2]. It possesses significant importance due to biodegradability, less pollutant emitting and non-toxic nature, displaying similar activity like conventional diesel[3]. Biodiesel is used in diesel engines with little or no engine modification[4]. Biodiesel is basically fatty acid methyl and/or ethyl ester produced from vegetable oil and animal fat[4–6]. Predominantly, *Jatropha* biodiesel is produced by transesterification process, which involves the reaction of triglycerides and free fatty acids of *Jatropha* oil (*J* oil) with excess alcohol, similar to low cost methanol in the presence of suitable catalyst[5,6]. Generally, transesterification can be catalysed by both basic and acidic catalysts[7]. Traditional alkali catalysts NaOH and KOH are not preferred because of serious saponification, slow reaction time and expensive purification[8]. Traditional acid catalysts like sulphuric acid and *p*-toluenesulphonic acid result in rigorous equipment corrosion and require long reaction time for high activity and cannot be recovered easily[9]. The solid catalyst faces low activity, low reaction rate, low stability, requires high temperature and easy deactivation[10]. Transesterification of *J* oil with different ionic liquids (ILs) have been reported in the literature, but they require higher temperature and result in low biodiesel yields[11].

Ionic liquids are now considered as green solvent which has attractive properties like low vapour pressure, negligible volatility, high conductivity, better catalytic activity, strong dissolution ability and potential for reusability[12–16]. However, use of acidic ionic liquids needs high temperatures (>180°C) to obtain high activities, resulting in an energy-consuming and expensive process[17,18]. This directed efforts to explore basic ionic liquids for the synthesis of biodiesel which revealed that the basic ionic liquid transesterification is time saving and offers potential for reusability than the acidic ionic liquid transesterification[19,20].

The purpose of the present work is to develop a facile one-pot process for the production of superior quality biodiesel from *J* oil through transesterification method using environment-friendly choline-based basic ionic liquid catalyst without any soap formation. Reaction conditions like temperature, time, molar ratio and catalyst dosage are optimized for obtaining the greatest conversion yields.

Experimental section

Materials

J oil was used as expelled in our institute (CSIR-CSMCRI, Bhavnagar), without any free treatment. Choline chloride was purchased from TCI Chemicals, Tokyo, Japan. Potassium hydroxide, sodium hydroxide, imidazole and methanol were purchased from SD Fine Chemicals Ltd, Mumbai. All chemicals were used as received. Two different bio-ionic liquid catalysts, namely choline hydroxide (ChOH) and choline imidazole (ChIM) were prepared in the laboratory (as indicated below in eqs (1) and (2) respectively) and were used in this study.

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