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K_2CO_3 in NH_4OH as an Effective Catalyst Mixture for the Transesterification of High Acid Value Mahua Oil

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In present study, biodiesel was synthesized from high free fatty acid content Mahua oil using K_2CO_3 in NH_4OH catalyst mixture through transesterification process. Addition of NH_4OH to K_2CO_3, enhanced the basic strength of the catalyst (K_2CO_3) by generating *in-situ* KOH in ammonium carbonate medium. The presence of ammonium carbonate in the reaction medium controlled the generation of intermediate water during methoxide formation and thereby increased the biodiesel yield. The maximum yield of 98.5% with a fatty acid methyl ester (FAME) content of 98.95% was obtained at the optimized condition of catalyst mixture of 1g K_2CO_3 in 0.5 g of NH_4OH, oil to methanol molar ratio 1:7 at 55 ºC in 75 min. Characterization of the obtained biodiesel has been carried out using GC-MS and ^{1}H NMR techniques. The physico-chemical properties of the oil and the synthesized biodiesel were tested according to the ASTM D6751 standards and the values are within the range.

Keywords: Mahua oil, Potassium carbonate, Ammonium hydroxide, Ammonium Carbonate, Catalyst mixture, Biodiesel.

INTRODUCTION

Fuels derived from renewable resources are one of the greatest solutions to alleviate the current reliance on diminishing fossil fuels [1]. Biodiesel is the most common substitute for petroleum diesel because it is a stable alternative energy source with the advantages of renewability, non-toxicity, lower pollution and biodegradability [2]. Commercial biodiesel is currently produced from first-generation edible oils such as soybean, rapeseed, palm and sunflower oil. However, the amount of edible oil feedstock available is insufficient to fulfil global fuel demand [3]. Biodiesel production from edible oils causes a conflict between energy and food, as well as deforestation and ecological imbalance, because it requires a considerable amount of fertile land for cultivation [4]. As a result, it is preferable to produce biodiesel from non-edible second generation feedstocks such as Mahua, Pongamia, Jatropha, Caster and others [5]. These biofuel crops can grow in non-agricultural and marginal lands with low maintenance cost [4].

Presently, commercial biodiesel is produced through base catalyzed transesterification process, as the method is more feasible and effective [5]. However, catalysis of transesterification reaction using conventional direct KOH catalyst despite of its faster rate of reaction leads to increased soap formation due to the formation of intermediate water molecules and presence of unreacted KOH in the reaction medium [6]. Many researchers used K_2CO_3 as an alternative catalyst to KOH as it does not produce water during the alkoxide formation reaction and also tolerant of free fatty acid (FFA) content in the feedstock [6-8]. Since, K_2CO_3 is a mild base [9] and sparingly soluble in methanol [10], the process consumes a large quantity of catalyst. As a result of the greater catalyst load, secondary saponification occurs and reduces the biodiesel yield [9]. To address this, an experiment was carried out utilizing K_2CO_3 in