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Characterization of the liquid product obtained by pyrolysis of karanja seed

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HIGHLIGHTS

- ▶ This paper highlights the chemical recycling of karanja seeds by thermal pyrolysis.
- ▶ Utilization of agricultural wastes.
- ▶ Production of the bio-oil from biomass.
- ▶ The results of thermal pyrolysis of different seeds carried out by different researchers.
- ▶ Suitability of liquid product obtained after thermal pyrolysis of karanja seed as an alternate fuel.

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ABSTRACT

Karanja (*Pongamia glabra*) seeds were pyrolyzed in semi-batch mode at a temperature range of 450–550 °C and at a heating rate of 20 °C/min. FTIR (Fourier transform infrared spectroscopy) analysis of the liquid product indicates the presence of alkanes, alkenes, ketones, carboxylic acids and aromatics rings. GC–MS (Gas chromatography–Mass spectrometry) demonstrated the presence of hydrocarbons with between 14 and 31 carbon atoms in a chain. The physical properties of the pyrolysis liquid were close to mixture of diesel and petrol.

1. Introduction

The recovery of energy from biomass and solid wastes has centered on biochemical and thermo-chemical processes. Of the thermo-chemical processes, pyrolysis is of interest, because it can lead to the production of fuels and useful chemicals. Products from the pyrolysis of biomass include residue chars, tars, and volatile gaseous components (Sharma et al., 2004). For many biomass systems, the products of pyrolysis can be controlled by regulating the heating and gas flow rates, pressure, sample size, and inorganic salts (Baliga et al., 2003). The liquid product of pyrolysis (pyrolysis oil) has the potential to be used as a fuel oil substitute. Liquid products are comprised of molecules derived from depolymerization and fragmentation reactions of three key biomass building blocks: cellulose, hemicellulose, lignin, protein and lipids. In contrast to petroleum fuels, liquid products contain a large amount of oxygen, usually 45–50 wt% (Piskorz et al., 2000). Seeds can be a source of pyrolysis products. For example, slow pyrolysis of pomegranate seeds was carried out by Suat and Selhan (2009) and a maximum liquid yield was obtained at 500 and 600 °C. The bio-chars had high bulk densities and calorific values. Beis et al. (2002) studied pyrolysis of safflower seed in a fixed-bed pyrolyzer to determine the effects of pyrolysis temperature, heating rate, particle size and sweep gas flow rate on product yields and their chemical compositions. The authors obtained a maximum oil yield of 44% at 500 °C at a particle size range of +0.425 to 1.25 mm, with a heating rate of 5 °C/min and sweep gas (N_2) flow rate of 100 cm^3/min. Rapeseed pyrolysis was performed by Onay and Kockar (2006) in a free-fall reactor at atmospheric pressure under nitrogen atmosphere and a maximum pyrolysis conversion of 78% was achieved at 700 °C. A liquid product yield of 75% was obtained at a final pyrolysis temperature of 600 °C, particle size range of 0.224–0.6 mm and a sweep gas flow rate of 100 cm^3/min. Karanja seeds, produced by *Pongamia glabra*, a tree adaptable to various climatic conditions and soil types, are another type of seeds that might be suitable

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