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Biodiesel Production from Edible Oil Wastewater Sludge with Bioethanol Using Nano-Magnetic Catalysis

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Abstract : Currently, most sludge from the wastewater treatment plants of edible oil factories is disposed to landfills, but landfill sites are finite and potential sources of environmental pollution. Production of biodiesel from wastewater sludge can contribute to energy production and waste minimization. However, conventional biodiesel production is energy and waste intensive. Generally, biodiesel is produced from the transesterification reaction of oils with alcohol (i.e., Methanol, ethanol) in the presence of a catalyst. Homogeneously catalysed transesterification is the conventional approach for large-scale production of biodiesel as reaction times are relatively short. Nevertheless, homogenous catalysis presents several challenges such as high probability of soap. The current study aimed to reuse wastewater sludge from the edible oil industry as a novel feedstock for both monounsaturated fats and bioethanol for the production of biodiesel. Preliminary results have shown that the fatty acid profile of the oilseed wastewater sludge is favourable for biodiesel production with 48% (w/w) monounsaturated fats and that the residue left after the extraction of fats from the sludge contains sufficient fermentable sugars after steam explosion followed by an enzymatic hydrolysis for the successful production of bioethanol [29% (w/w)] using a commercial strain of Saccharomyces cerevisiae. A novel nano-magnetic catalyst was synthesised from mineral processing alkaline tailings, mainly containing dolomite originating from cupriferous ores using a modified sol-gel. The catalyst elemental chemical compositions and structural properties were characterised by X-ray diffraction (XRD), scanning electron microscopy (SEM), Fourier transform infra-red (FTIR) and the BET for the surface area with 14.3 m^2/g and 34.1 nm average pore diameter. The mass magnetization of the nano-magnetic catalyst was 170 emu/g. Both the catalytic properties and reusability of the catalyst were investigated. A maximum biodiesel yield of 78% was obtained, which dropped to 52% after the fourth transesterification reaction cycle. The proposed approach has the potential to reduce material costs, energy consumption and water usage associated with conventional biodiesel production technologies. It may also mitigate the impact of conventional biodiesel production on food and land security, while simultaneously reducing waste.

Keywords : biodiesel, bioethanol, edible oil wastewater sludge, nano-magnetism
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