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Biorefinery approach of microalgae feedstock for the production of bioethanol and biodiesel

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The continued use of fossil fuels depletes the reserves; more than 75% of petroleum based fuels are burnt in the transportation sector. The utilization of global energy is expected to be increased in the future due to increase in population and demand. Therefore, there is a need for alternative fuel, which is not only satisfying the need, but also solve the environmental problems. Microalgae feedstocks, a reliable biofuel source, have drawn much attention as an alternative and renewable. This is due to the microalgal species have the excellent photosynthetic efficiencies and the biomass reproducibility potential than any other terrestrial crops. This study is about the integrated approach of ethanol and biodiesel production from algal biomass. This integrated method is to develop the microalgae based biorefinery model. The present study focuses on the biorefinery approach of integrated production of bioethanol and biodiesel from microalgae feedstock. Various pretreatment methods were used to determine the maximum recovery of sugars from Scenedesmus sp. The total sugar yield of 84% was obtained when pretreated separately by acid hydrolysis. The hydrolysate produced 90% of ethanol (theoretical yield) after the fermentation. Enzyme catalyzed ultrasound assisted direct transesterification of biomass was performed and the maximum of 91% methyl ester yield, 2.6% glycerol carbonate and 5.6% glycerol dicarbonate was obtained. The integrated process of initial acid hydrolysis produces 84% of total sugar. The sugar extracted biomass was initiated with enzyme catalyzed direct transesterification with ultrasound irradiation. The obtained hydrolysate was further fermented with S. cerevisiae and at the optimized conditions of fermentation 90% of ethanol (theoretical yield) was obtained. The conditions of direct transesterification using enzyme were optimized and produces 89% of biodiesel yield with 2.1% glycerol carbonate and 4.9% glycerol dicarbonate. Thus, the microalgal biomass efficiently produces both ethanol and biodiesel as well glycerol carbonate, which could be the biorefinery model for sustainable future development.

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A comprehensive study on production of torrefied biofuel using inclined rotary reactor

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Torrefaction is a thermal pre-treatment between 200-300°C, at low heating rates (<20°C/min) in inert environments or with low oxygen concentrations. Torrefaction produces a char product with higher specific energy, lower equilibrium moisture content than untreated material, brittleness requiring low grinding energy, and resistive to environmental degradation. Additionally, torrefaction provides a product of uniform qualities. Torrefaction process, thus, appears as excellent solution for pretreating biomass. A two-stage, inclined continuous rotary torrefier with novel flights has been developed in the Biomass Conversion Laboratory at Dalhousie University for improving biomass torrefaction process as is shown in Figure 1. Experimental work on torrefaction of fine poplar wood particles (0.5-1.0 mm) in the torrefier was undertaken for a deeper understanding of the working of such torrefiers where the volatile gas released was used as the torrefaction medium instead of nitrogen. The rotary torrefier is operated under different operating conditions by varying its rotational speed, tilt angle and temperature. Chemical and physical properties of the torrefied products included ultimate and proximate analysis, polymeric analysis, energy density, mass yield, energy yield, and bulk density were measured. Temperature and conversion at different interior points along the length of the rotary reactor while the biomass was being progressively torrefied in it were measured. Fixed carbon content, volatile and energy density of biomass undergoing torrefaction varied linearly along the length of the torrefier. Typical values of change in heating value, mass yield and energy yield of torrefied biomass was 40%, 34% and 48% respectively for 300°C and 5 RPM and 1° of tilt angle. Results showed that temperature is the most important parameter in the torrefaction process.

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