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Flash hydrolysis, a sustainable approach in the processing of microalgae for biofuels and nutrients management

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Achieving a large scales operation of algae to biofuels requires better energy balances and technological breakthroughs in the area of open pond algae cultivation, harvesting, processing, and resource utilization (water and nutrients). Algae contain three major biopolymers including lipids, carbohydrates, and proteins. Carbohydrates and lipids are precursor to biofuels whereas proteins are the cause of the loss of nitrogen fertilizer if it is not recovered and recycled.

The present study on flash hydrolysis capitalizes on the difference in reaction kinetics of microalgae polymeric components and fractionates proteins in aqueous phase in seconds of residence time using subcritical water. All the experiments were conducted using flocculated Scenedesmus sp. cultivated using photobioreactors or one-acre open pond. The effect of temperature and residence time on protein hydrolysis to water-soluble fractions (algal hydrolyzate) and yield of lipid-rich solids (biofuels intermediate) was studied using continuous flow reactor. More than 2/3rd of the total nitrogen and phosphorous content in algae was extracted within 10 s of residence time above 240 ˚C. Our study shows that the on-farm flash hydrolysis process can provide a novel and fast method to recycle macronutrients (N & P) and water. In this study, the algal hydrolyzate (nutrient-rich water) recovered after flash hydrolysis was recycled for cultivating microalgae. The carbon content of biofuels intermediate increased up to 66 wt% making it lipid- and energy-dense feedstock suitable for biofuels production. These solids were further characterized using GC-MS, NMR, and flash pyrolysis to evaluate their chemical composition and suitability for producing liquid fuels.

Biography

Sandeep Kumar, Assistant Professor of Civil and Environmental Engineering, earned his Ph.D. in Chemical Engineering from Auburn University in the area of biomass to biofuels. Dr. Kumar's research focuses on hydrothermal processes for the conversion of biomass/algae to different biofuels such as biocrude/bio-oil, biochar, syngas, and hydrogen which is directly aimed at supporting the commercial production of biofuels from lignocellulosic/algae feedstock. His expertise is in high temperature and high pressure hydrothermal reactions of biomass. Dr. Kumar has more than 15 years of experience in industry and R&D with responsibilities in new process development, process engineering and project management.

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