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Sustainable Production of Algae through Nutrient Recovery in the Biofuel Conversion Process

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Abstract : The sustainability of algae to biofuel processes is seriously affected by the energy intensive production of fertilizers. Large amounts of nitrogen and phosphorus are required for a large-scale production resulting in many cases in a negative impact of the limited mineral resources. In order to meet the algal bioenergy opportunity it appears crucial the promotion of processes applying a nutrient recovery and/or making use of renewable sources including waste. Hydrothermal (HT) conversion is a promising and suitable technology for microalgae to generate biofuels. Besides the fact that water is used as a "green" reactant and solvent and that no biomass drying is required, the technology offers a great potential for nutrient recycling. This study evaluated the possibility to treat the water HT effluent by the growth of microalgae while producing renewable algal biomass. As already demonstrated in previous works by the authors, the HT aqueous product besides having N, P and other important nutrients, presents a small fraction of organic compounds rarely studied. Therefore, extracted heteroaromatic compounds in the HT effluent were the target of the present research; they were profiled using GC-MS and LC-MS-MS. The results indicate the presence of cyclic amides, piperazinediones, amines and their derivatives. The most prominent nitrogenous organic compounds (NOC's) in the extracts were carefully examined by their effect on microalgae, namely 2-pyrrolidinone and β-phenylethylamine (β-PEA). These two substances were prepared at three different concentrations (10, 50 and 150 ppm). This toxicity bioassay used three different microalgae strains: Phaeodactylum tricornutum, Chlorella sorokiniana and Scenedesmus vacuolatus. The confirmed IC50 was for all cases ca. 75ppm. Experimental conditions were set up for the growth of microalgae in the aqueous phase by adjusting the nitrogen concentration (the key nutrient for algae) to fit that one established for a known commercial medium. The values of specific NOC's were lowered at concentrations of 8.5 mg/L 2-pyrrolidinone; 1mg/L δ-valerolactam and 0.5 mg/L β-PEA. The growth with the diluted HT solution was kept constant with no inhibition evidence. An additional ongoing test is addressing the possibility to apply an integrated water cleanup step making use of the existent hydrothermal catalytic facility.

Keywords : hydrothermal process, microalgae, nitrogenous organic compounds, nutrient recovery, renewable biomass
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