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Entitled

A CONSORTIUM OF MICROALGAE AND WASTEWATER ACTIVATED SLUDGE TO GENERATE BIOHYDROGEN

by

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Abstract

Hydrogen is a clean source and carbon-free source of energy that can be generated photobiologically using green microalgae with 122 kJ/g of energy output which is 2.75 times that of hydrocarbon-based fuels. However, challenges, such as presence of molecular oxygen (O_2) within the cells, hinder their practical application. Molecular O_2, emanating from the activity of photosynthesis, acts as a powerful and effective switch that turns off bioH_2 production activity. The objective of this research is to develop an innovative approach to increase the yield and sustain bioH_2 photoproduction. For this purpose, a consortium of microalgae and wastewater activated sludge (WWAS) will be used to scavenge intracellular molecular O_2 within representative species of microalgae. The relatively recent studies investigated the co-culture of microalgae and pure bacterial strains; however, the current study proposes the co-culture system integrated with WWAS. The bacteria present in the WWAS will consume the molecular O_2 produced during algal metabolism. The co-culture showed exact inverse relation between H_2 and O_2 during incubation period. Almost 45% of the gas composition comprises H_2 in the final concentration. 1246 mL H_2 L^{-1} was produced with least 57 mL O_2 L^{-1} during 6 days of incubation. The co-culture with optimized conditions will be employed on semi continuous and continuous flow reactors to check the feasibility for sustained bioH_2 yield. The maximum bioH_2 concentrations of 421.1 µmol L^{-1} and 56.6 µmol L^{-1} were observed in the exponential and steady-state phases while operating in sequential flow batch reactor (SFBR) mode. The proposed system will also remove organics while improving water quality for reuse, accumulating biomass for biofuel production, and generating valuable gasses such as bioH_2. The co-culture inoculum ratio of 1:1.5 v/v (*Chlorella vulagris*:WWAS) achieved ~33% COD and ~47% TS removal efficiencies in O_2-deficient tris-acetate-phosphate (TAP) medium during five days of incubation period. This project will contribute to the shift from a traditional mode of energy production from fossil fuels, use, and disposal to a circular economy wherein the vast potential of wastewater as a source of valuable nutrients and energy is exploited.

Keywords: Biogas, Biohydrogen, Oxygen scavenging, Algal-bacterial co-culture, Photobioreactor, Activated sludge.