Enhanced Hydrogen and Third-Generation Biofuel Production from Modified Algae

Vemulapalli, Anoop

Algae are one of the most promising sources of biomass because of their environmental sustainability, and the direct use of algal byproducts as transportation fuels. Hydrogen is one of the fastest growing areas of the energy sector. This project introduces a novel technique that allows hydrogen production to be biologically synthesized without effecting lipid yields. Three different methods were used to improve hydrogen production: 1.) Stress factor deprivation 2.) Light cycle manipulation 3.) Ferredoxin manipulation. Increasing ferredoxin FDX1 levels and inhibiting lesser efficient ferredoxins FDX2-6 was hypothesized to allow the algae to optimize their natural hydrogen production. As hypothesized, this overexpression of FDX1 and knockout of FDX2-6 resulted in the highest hydrogen yield per mole of algae at 13.21 moles of hydrogen per mole of algae. To determine FDX1 levels in the chloroplast a novel ARSA fluorescence assay was developed. This novel assay utilizes the fluorescent reaction between the enzyme Arylsulfatase A and FDX1. A modification of a common biological hydrogen assay was also engineered to accurately determine the amount of hydrogen gas the algal culture produced. Due to the nature of the biofuel industry, a commercially viable raceway (CACBA) was designed and engineered in previous years of this research study. This year CACBA has been improved with a large-scale hydrogen storage tank that uses staged membrane filtration to isolate hydrogen gas. In conclusion, this research study significantly improves the commercial viability of algal byproducts.

Awards Won:

Sigma Xi, The Scientific Research Honor Society: White House Presidential Inovation Fellow SmartAmerica Challenge Award Second Award of $2,000