Enhanced Third-Generation Biofuel Production from Genetically Modified Algae

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Algae are one of the most promising sources of biofuels because of their environmental sustainability, and the direct use of algal lipids as fuels. Conventional methods of extracting these lipids, however, prevent algal biofuels from being a commercially viable option. This project introduces a novel technique that cuts costs of lipid extraction through genetically modifying the algae. As opposed to conventional hexane extractions that break the cell wall, thereby killing the algae, gene modifications of Acyl-ACP synthetase (Δaas) and truncated thioesterase (tesA) allow for automatic excretion of lipids. In addition to excretion, lipid production itself was also optimized. The knockout of Δaas yielded 44.90 mg/L and the Δaas 'tesA culture yielded 33.15mg/L of lipids. As hypothesized, cell functions were not inhibited by the transformation; therefore, a single culture of algae is able to continually produce and excrete lipids as opposed to the re-culturing necessary in traditional methods.To maintain high algae cultures for large-scale production, an original raceway system, CACBA, was developed to efficiently culture algae through specifically engineered cultivation conditions. This brought the algae culture on par with the biofuel demand; each culture of algae holds millions of lipid-excreting cells. Emissions tests were conducted on biodiesel mixtures for a vision of a smooth transition from petroleum to biofuels. It was found that as the percentage of biofuel increased, the harmful emissions causing air pollution decreased. As of 2014, optimization rates were determined to be 35.39% biofuel and 64.61% petroleum. It was concluded that this project significantly improves the commercial viability of algal biofuels, potentially lowering costs to $2.87/gallon of fuel.

Awards Won:

Third Award of $1,000