Optimizing Nannochloropsis Growing Conditions for Biodiesel Production Through Analysis of Lipid Content

Liu, Steven (School: Shady Side Academy)

Energy-dense algae are more suitable feedstocks for biodiesel and circumvent many of the problems posed by current biodiesel feedstocks, such as the requirement for arable land. Nannochloropsis is a promising genus of algae due to its high productivity and lipid content. Here I show how to optimize the growing medium composition for increased biodiesel quality while maintaining high productivity by quantifying the constituent fatty acid type and composition using gas chromatography. The algae are grown in two groups of three 2.5L glass jugs spanning three concentration levels of nitrates and phosphates. After harvesting with flocculation, lipids are extracted and transesterified into fatty acid methyl esters, which is biodiesel. The maximum monounsaturated fatty acid concentration of 62.68% of total fatty acids was reached in a low nitrate and phosphate concentration (L-NP), which corresponds to high-quality biodiesel. The cetane number of L-NP algal biodiesel is approximately 62 and is higher than all other biodiesel and petroleum-based diesel, which corresponds to a high-performing fuel. Its oxidative stability is less than 6.2 mg of impurities per 100 mL of fuel after storing for 1 month and is significantly higher than all other biodiesel and comparable to petroleum-based diesel. This results in a more practical biodiesel that can be stored for longer. Through this study, a scientific breakthrough was achieved by maximizing both the quality of biodiesel produced, which is beyond any currently available biodiesel, and also the quantity with productivity of greater than 100 times the current biodiesel feedstocks.

Awards Won: