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Enhancement of Growth and Lipid Accumulation in Microalgae with Aggregation Induced Emission-Based Photosensitiser

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Abstract : Mass production of microalgae has become a focus of research owing to their promising aspects for sustainable food, biofunctional compounds, and biofuel feedstock. However, low lipid content with optimum algal biomass is still a challenge that must be resolved for commercial use. This research aims to determine the effects of light spectral shift and reactive oxygen species (ROS) on growth and lipid biosynthesis in a green microalga, Chlamydomonas reinhardtii. Aggregation Induced Emission (AIE)-based photosensitisers, CN-TPAQ-PF6 ($[C_{32}H_{23}N_4]+$) with high ROS productivity, was introduced into the algal culture media separately for effective conversion of the green-yellow-light to the red spectra. The intense photon energy and high-photon flux density in the photosystems and ROS supplementation induced photosynthesis and lipid biogenesis. In comparison to the control, maximum algal growth (0.15 g/l) was achieved at 2 µM CN-TPAQ-PF6 exposure. A significant increase in total lipid accumulation (146.87 mg/g dry biomass) with high proportion of 10-Heptadecanoic acid (C17:1) linolenic acid (C18:2), α-linolenic acid (C18:3) was observed. The elevated level of cellular NADP/NADPH triggered the Acetyl-Co-A production in lipid biogenesis cascade. Furthermore, MTT analysis suggested that this nanomaterial is highly biocompatible on HaCat cell lines with 100% cell viability. This study reveals that the AIE-based approach can strongly impact algal biofactory development for sustainable food, healthy lipids and eco-friendly biofuel.

Keywords : microalgae, photosensitiser, lipid, biomass, aggregation-induced-emission, reactive oxygen species
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