MWP – Young Researcher Abstract 2024

Project title: Plant Nanobionics: Nanoparticles for Boosting the CO_2 Uptake and Photosynthetic Efficiency in Plants.

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Abstract (approx. 200 words)**:**

Photosynthesis, the process by which plants convert CO_2 and sunlight into sugars and oxygen, is fundamental to life on Earth. However, one major limitation of photosynthesis is the initial carboxylation reaction, where atmospheric CO_2 is converted into sugar precursors (3-PGA) by the enzyme RuBisCO. RuBisCO's activity is highly restricted by its low affinity for CO_2 and limited CO_2 diffusion through plant tissues, considerably reducing the potential photosynthetic efficiency of plants. As climate change and population growth intensify, enhancing photosynthesis becomes crucial. Plant nanobionics, which blends materials science and plant biology, offers innovative solutions.

Our research focuses on improving CO_2 uptake in wild-type plants and plant cells using **green-fluorescent chitosan-modified polyethyleneimine** (**gPEI-Chi**) nanoparticles. *In vitro*, these nanoparticles were shown to capture atmospheric CO_2 and enhance 3-PGA production by 20%. *In planta*, these nanoparticles continue to uptake CO_2, self-integrate into photosynthetic centers, and could potentially address CO_2 diffusion barriers and RuBisCO's affinity limitations. Additionally, **gPEI-Chi** nanoparticles were shown to safely enter plant cells in culture, modifying CO_2 concentration dynamics without harming the cells.

This advancement could significantly benefit the forest-based industry and society. By increasing photosynthetic efficiency, we could enhance plant growth, improve CO_2 sequestration, and support sustainable agricultural practices. Addressing scalability and environmental safety, while overcoming delivery method obstacles and ensuring long-term plant health, will enable the development of plant bio-hybrid systems that could boost productivity and CO_2 capture, paving the way for a greener future.

Key words: *plant nanobionics, nanoparticles, chitosan-modified polyethyleneimine, CO2 capture, photosynthesis.*