Photogene Fusion: Enhancing Photosynthesis Through Agrobacterium-Mediated Delivery of the 3S5 Ruby Plasmid for Sustainable Carbon Capture

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Due to the global demand for CO_2 removal mechanisms, solutions such as direct air carbon capture are being used to filter atmospheric CO_2. However, these methods often contribute to environmental damage such as groundwater acidification. Photosynthesis, a CO_2 consuming process, can be augmented for applications in carbon capture. This research aimed to enhance photosynthesis by filtering wavelengths that inhibit photosynthesis. The 3S5 Ruby Plasmid, which expresses the pathway that converts tyrosine to the pigment betacyanin, was administered to plants to evaluate if the pigment's antioxidant and UV-absorbing properties increase photosynthesis. The plasmid was injected in 6 out of 12 Lactuca sativa plants studied via bacterial conjugation. Spectrophotometric analysis, CO_2 assimilation tracking, and biomass quantification were used to extrinsically evaluate differences in photosynthesis. A statistically significant increase was observed when comparing absorbance of tissue-based solutions at wavelengths of photoinhibition (range of p-values = 0.0033-0.0485), indicating enhanced photoprotectivity. Transformed plants also demonstrated a 37.34% increase in CO_2 assimilation rate, and as a result, there was a 57.03% increase in the biomass composition of betacyanin-producing plants, further demonstrating increased photosynthetic capability. Increased CO_2 consumption, biomass composition, and stressor wavelength absorption were observed among transformed plants, which are key indicators of photosynthetic enhancement due to in vivo Betacyanin production. This research offers an environmentally conscious strategy to address the global demand for carbon sequestration.

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