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P.I.3 — Environmental stress as a driver of pigment modulation in *Rhodobacter capsulatus*

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Rhodobacter capsulatus; Carotenoid production; Oxidative stress; Pigment regulation

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Poster Presentations #20

P.I.3 — Environmental stress as a driver of pigment modulation in *Rhodobacter capsulatus*

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The transition toward circular bioprocessing requires sustainable microbial platforms capable of converting residual streams into valuable bioproducts. Purple phototrophic bacteria (PPB), such as *Rhodobacter capsulatus*, are promising candidates due to their metabolic versatility and their capacity to produce microbial protein and carotenoids with antioxidant and photoprotective functions. This study evaluates how environmental stressors, specifically oxygen availability and UV-C exposure, regulate carotenoid biosynthesis and pigment composition in *R. capsulatus*.

Pigments were extracted using organic solvents and analyzed by UV–Vis spectrophotometry and high-performance liquid chromatography (HPLC). UV-C irradiation reduced cell viability, reflecting its damaging effect on microbial populations, but surviving cultures showed an increase in total carotenoid accumulation of approximately 10–20%. This response suggests the activation of photoprotective and oxidative-stress defense mechanisms. In addition, UV-C exposure induced a temporary delay in growth that progressively decreased over successive cycles, indicating an adaptive response to repeated stress. However, carotenoid accumulation was not strictly proportional to exposure intensity or cycle number, suggesting the existence of regulatory limits in pigment overproduction (Figure 1). Oxygen availability strongly influenced carotenoid composition and culture pigmentation. Under aerobic conditions, cultures shifted toward reddish coloration, while anaerobic cultures remained more yellowish. Spectrophotometric and HPLC analyses confirmed that oxygen promoted the CrtA-mediated oxidation of spheroidene into spheroidenone, a ketocarotenoid associated with enhanced oxidative-stress quenching and photoprotective capacity.

Overall, these results demonstrate that controlled environmental stress can modulate carotenoid biosynthesis in *R. capsulatus*. Oxygen acts as a key regulator of pigment composition, while repeated UV-C exposure promotes carotenoid accumulation and physiological adaptation. These findings highlight the potential of stress-based cultivation strategies to enhance carotenoid production in PPB systems and support their integration into scalable bioprocesses for the sustainable production of high-value compounds.

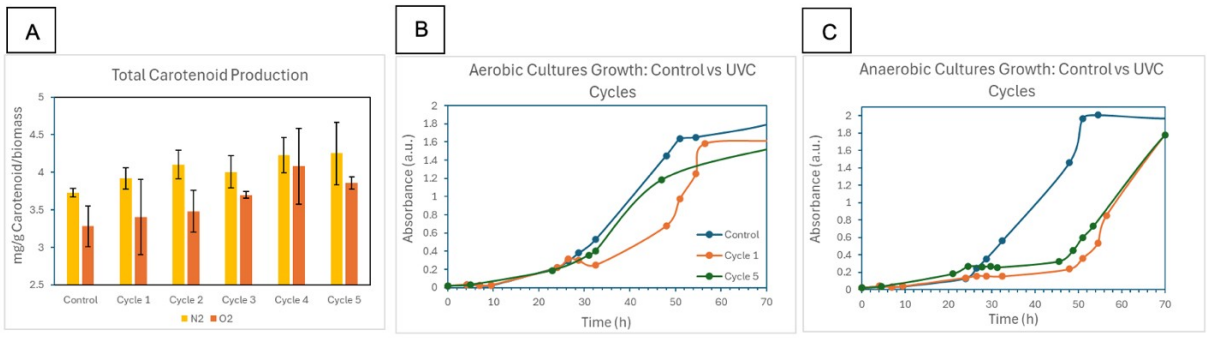


Fig 1. (A) Total carotenoid production (mg carotenoids/g biomass) per cycle under UV-C irradiation compared to non-irradiated controls (N_2 and O_2). (B) Growth curves (absorbance, a.u.) of aerobic cultures for selected cycles vs control. (C) Growth curves (absorbance, a.u.) of anaerobic cultures for selected cycles vs control.

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