Electrochemically - assisted growth of purple phototrophic bacteria for PHB production

biotechnology for a sustainable environment

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INTRODUCTION

Purple phototrophic bacteria (PPB) are one of the most versatile microorganisms on Earth. They can fall within photoheterotrophic, chemoheterotrophic or even photoautotrophic organisms. It is due to this variety of metabolic pathways that PPB have risen great interest in biotechnological processes, for example, biopolymer and biomass production (Monroy & Buitrón, 2020).

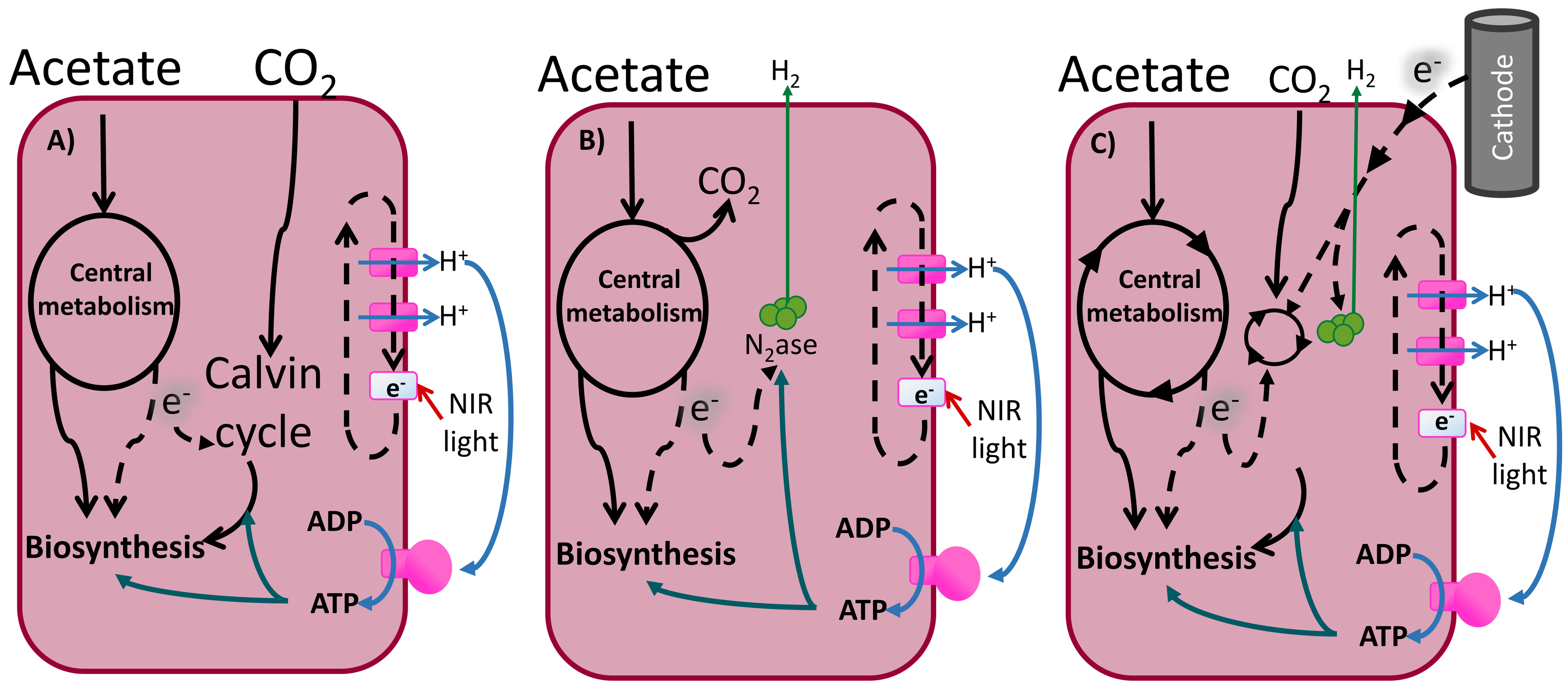

Figure 1: Different metabolisms in PPB. **A)** Autotrophic growth **B)** Nitrogen fixation and hydrogen production **C)** Electrochemically assisted growth. Figures adapted from (McKinlay & Harwood, 2010).

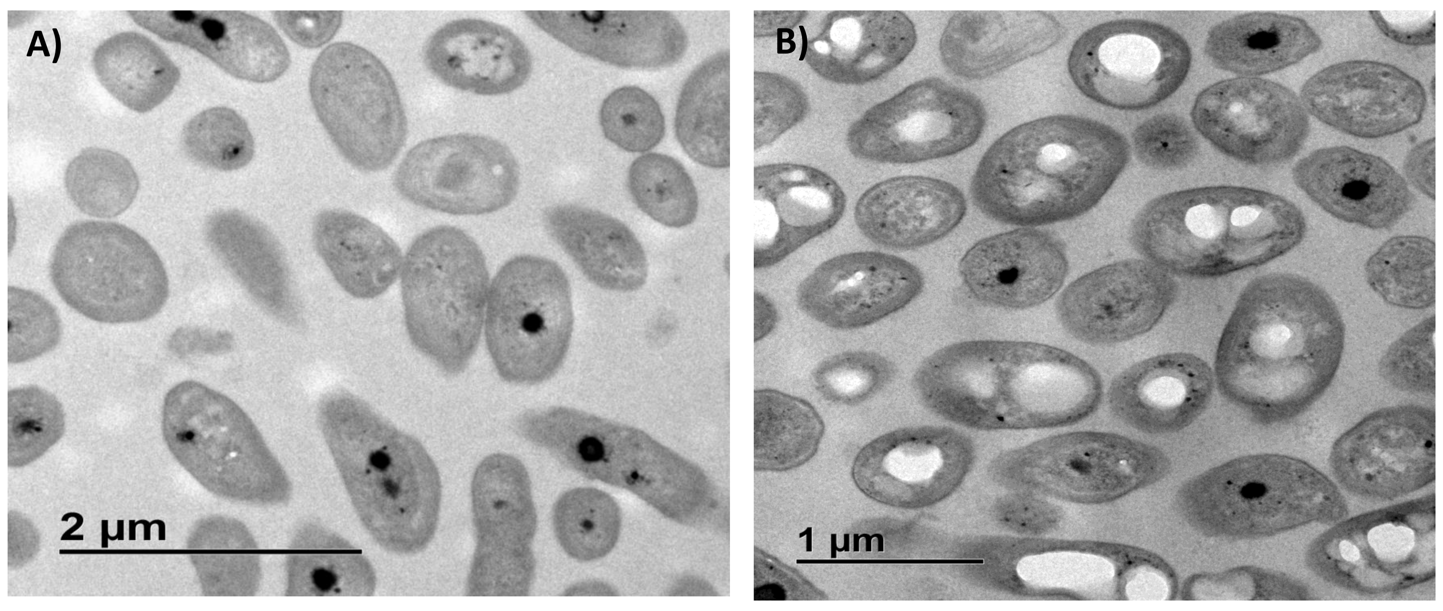

Figure 2. Transmission electron micrograph. **A)** Purple phototrophic mixed culture without PHB granules. Magnification 2000X. **B)** Purple phototrophic bacteria mixed culture with PHB granules. Magnification 3000X.

Microbial Electrochemical Technologies (METs) and the electrode-microbe interaction can be exploited in diverse systems. For example, in Microbial Electrochemical Synthesis (MES) we can modulate the bacterial metabolism to optimise added-value products generation.

The purpose of this work is to study the influence of electric current in PPB metabolism, and more specifically, in PHB production.

METHODS

The bacterial enrichment was carried out from brewery wastewater, to activate PPB growth, the reactors were irradiated with Near-Infrared light.

Two conditions were performed in two different reactors: polarized and open circuit conditions. To induce PHB synthesis we made use of the *"**feast and famine**"* technique (Padovani, Emiliani, Giovanelli, Traversi, & Carlozzi, 2018).

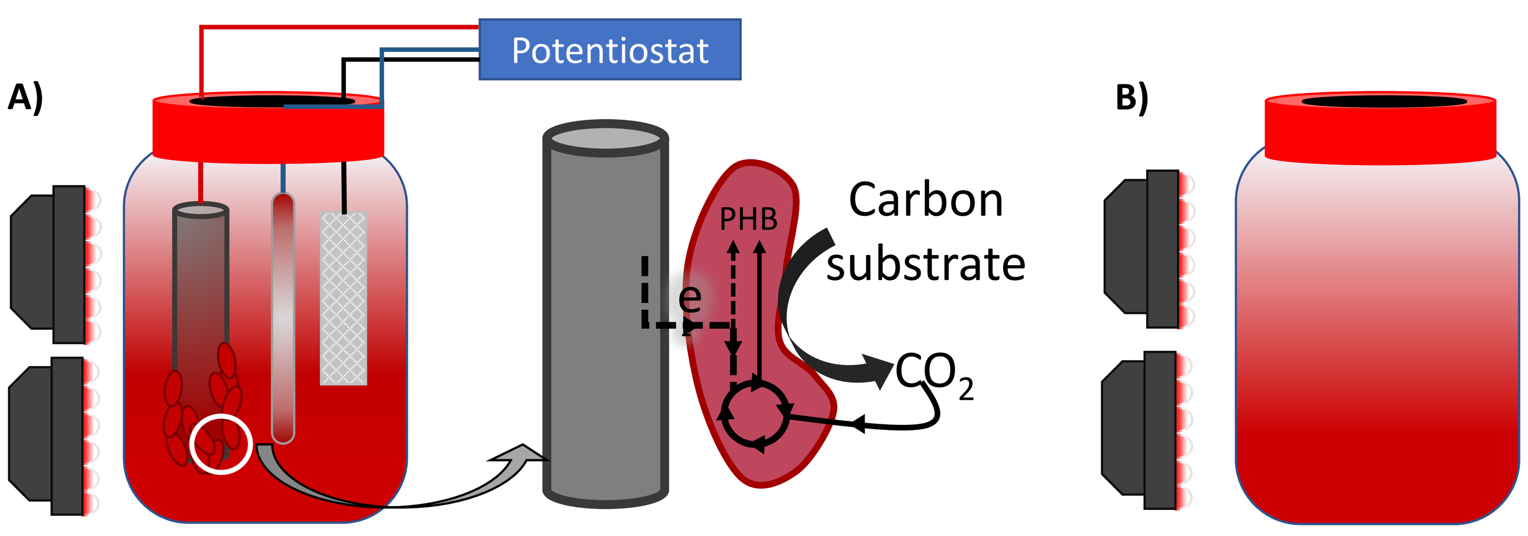

Figure 3. Experiment design. **A)** Polarized reactor and the mechanism by which the electrode donates electrons to the microorganisms. **B)** Open circuit reactor.

Microbial growth was measured by volatile solids (VVSS), PHB production was indirectly measured by crotonic acid concentration in the High Performance Liquid Chromatograph (HPLC). In order to observe PHB granules, Transmission Electron Microscopy (TEM) was performed.

Electric current and electrochemical potential were monitorized every second.

RESULTS

During the first stages of the experiment there is not sign of PHB synthesis. Nonetheless, when the microbial consortium is subjected to nutrient deficiency, a substantial increase in PHB production is noticed.

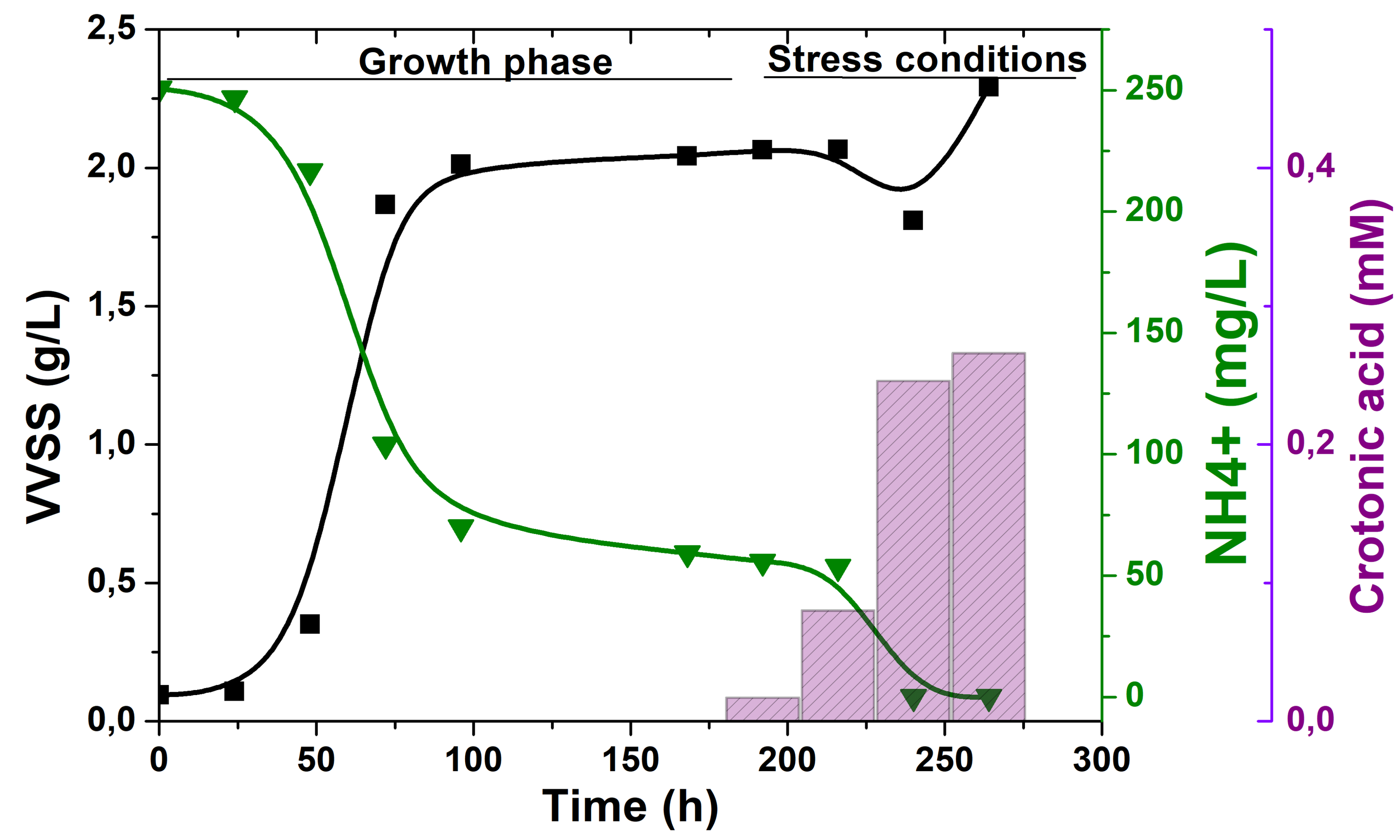

Figure 4. Microbial growth (black squares), ammonium consumption (green down triangles) and PHB production (violet columns). During growth phase there is enough nutrients for ordinary microbial proliferation while during stress conditions there is nitrogen deficiency.

CONCLUSIONS

- **An enriched purple phototrophic bacteria mixed culture is capable of PHB synthesis under stress conditions such as ammonium absence.**
- **The main goal of this work is to demonstrate that the polarized reactor could increase the PHB production compared with the open circuit reactors.**

Bibliography

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