Circular Economy in Food Industry Waste Management (BIVALIA Workshop2 - 2026)

Editors: Elena Diaz Nieto; Francisco Heras Muñoz; Juan Antonio Melero Hernández; Manuel Gertrudix
Madrid, BIVALIA, UAM-URJC, 2026
DOI: 10.5281/zenodo.22206833 · CC BY 4.0
Full volume: https://books.ciberimaginario.cloud/libro/bivalia-w2-2026

OFFPRINT · PP. 45–46

P.I.8 — Electrochemical control of CO_2 fixation and high-value biomass production in *Rhodopseudomonas*

María José García-López[1,2*], Emma Barahona[3,4], Daniel Puyol[1,2], Amanda Prado de Nicolás[1]

1: Department of Chemical and Environmental Technology, Universidad Rey Juan Carlos | 2: Instituto de Investigación de Tecnologías para la Sostenibilidad (ITPS), Universidad Rey Juan Carlos | 3: Department of Biology and Geology, Physics and Inorganic Chemistry, Universidad Rey Juan Carlos | 4: Instituto de Investigación en Cambio Global (IICG-URJC), Universidad Rey Juan Carlos

Purple phototrophic bacteria, Photoelectroautotrophy, CO_2 fixation, Bioelectrochemical systems, CoQ10

HOW TO CITE THIS CONTRIBUTION

María José García-López, Emma Barahona, Daniel Puyol, Amanda Prado de Nicolás. (2026). P.I.8 — Electrochemical control of CO_2 fixation and high-value biomass production in Rhodopseudomonas. In: Diaz Nieto, E., Heras Muñoz, F., Melero Hernández, J. A., Gertrudix, M. (Eds.), Circular Economy in Food Industry Waste Management (BIVALIA Workshop2 - 2026), pp. 45–46. BIVALIA, UAM-URJC. https://doi.org/10.5281/zenodo.22206833

Poster Presentations #25

P.I.8 — Electrochemical control of CO₂ fixation and high-value biomass production in *Rhodopseudomonas*

María José García-López[1,2], Emma Barahona[3,4], Daniel Puyol[1,2], Amanda Prado de Nicolás[1]*

[1] Department of Chemical and Environmental Technology, Universidad Rey Juan Carlos | [2] Instituto de Investigación de Tecnologías para la Sostenibilidad (ITPS), Universidad Rey Juan Carlos | [3] Department of Biology and Geology, Physics and Inorganic Chemistry, Universidad Rey Juan Carlos | [4] Instituto de Investigación en Cambio Global (IICG-URJC), Universidad Rey Juan Carlos

Correspondence: mjose.garcia.lopez@urjc.es

Keywords: *Purple phototrophic bacteria, Photoelectroautotrophy, CO_2 fixation, Bioelectrochemical systems, CoQ10*

Purple phototrophic bacteria (PPB) are emerging as promising microbial platforms for sustainable carbon capture and resource recovery due to their exceptional metabolic versatility and capacity for extracellular electron transfer. This study aimed to isolate novel electroactive *Rhodopseudomonas* strains from pig slurry and evaluate their potential for photoelectroautotrophic CO_2 fixation, biomass production, and coenzyme Q10 (CoQ10) biosynthesis, contributing to the development of bioelectrochemical systems for biogas upgrading.

Three environmental *Rhodopseudomonas* isolates (*Rp6, Rp12, and R25*) were obtained and compared with the model electroactive strain *Rhodopseudomonas palustris TIE-1*. The strains were cultivated under photoheterotrophic conditions using acetate or butyrate and subsequently transitioned to photoelectroautotrophic growth in bioelectrochemical reactors with a cathode polarized at −0.4 V vs. Ag/AgCl as the sole electron donor and bicarbonate/CO_2 as the carbon source. Biomass production, inorganic carbon fixation, electrochemical activity, and intracellular CoQ10 accumulation were evaluated.

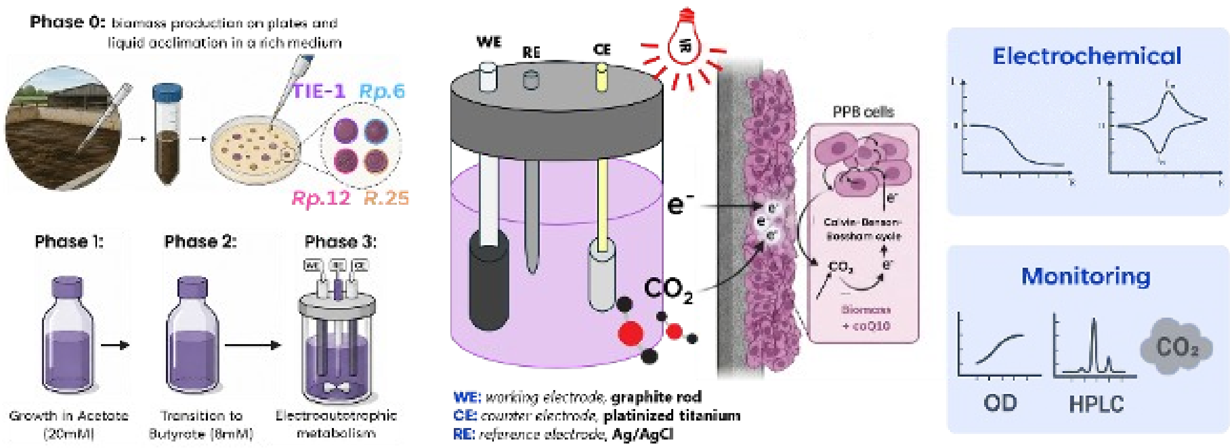

Figure 1. Experimental design for the isolation and photoelectroautotrophic evaluation of electroactive Rhodopseudomonas strains.

All four strains successfully established photoelectroautotrophic growth, demonstrating their ability to directly utilize cathode-derived electrons for CO_2 assimilation. The environmental isolates exhibited superior biomass production compared with *TIE-1*, with *Rp6* reaching up to 1.17 g dry cell weight (DCW) L^{-1}. Chronoamperometric and cyclic voltammetric analyses confirmed extracellular electron uptake in all strains, although distinct electrochemical behaviours suggested differences in electron transfer mechanisms. Cathodic current consumption was closely associated with bicarbonate availability, indicating that electron uptake was coupled to inorganic carbon fixation. Under photoelectroautotrophic conditions, *Rp6* achieved the highest CO_2 fixation, corresponding to approximately 1.18 g CO_2 L^{-1}, equivalent to the CO_2 contained in approximately 1.6 L of typical anaerobic digestion biogas.

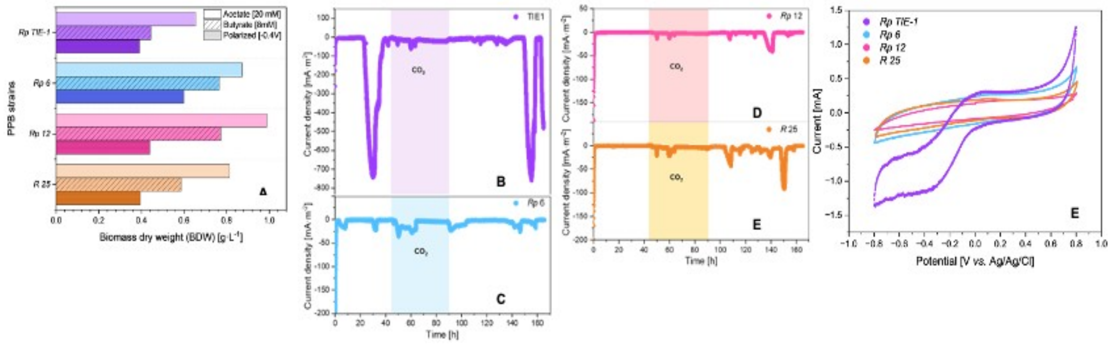

Figure 2. (A) Final biomass production, (B–E) chronoamperometric response during CO_2 feeding, and (F) cyclic voltammograms of Rhodopseudomonas strains under photoelectroautotrophic conditions.

Electrode-driven metabolism also significantly enhanced intracellular CoQ10 accumulation. Compared with photoheterotrophic cultivation, cathodic polarization increased CoQ10 content by approximately two- to three-fold in the environmental isolates, with *Rp6* reaching 7.4 mg g^{-1} DCW. These findings demonstrate that electroactivity extends beyond the model strain *TIE-1* and reveal novel *Rhodopseudomonas* isolates capable of simultaneously converting biogas-derived CO_2 into microbial biomass while enhancing the production of a high-value nutraceutical. This work establishes electroactive PPB as promising biocatalysts for integrating carbon capture, biogas upgrading, and sustainable production of food-grade biomass and valuable bioproducts within circular bioeconomy frameworks.

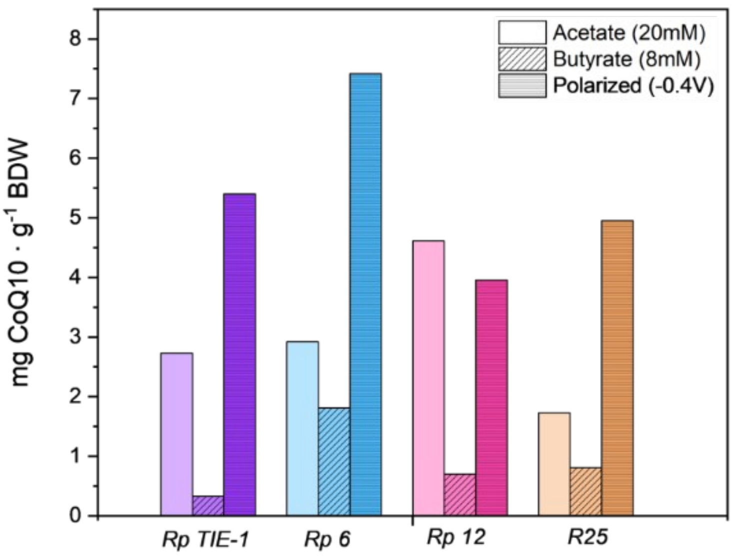

Figure 3. CoQ10 content of the Rhodopseudomonas strains under photoheterotrophic conditions (acetate 20 mM or butyrate 8 mM) and photoelectroautotrophic conditions (−0.4 V vs. Ag/AgCl).