RENEW

Resource recovery of the future: water reuse for new bioplastics with tunable lifespan

Water4All
Water security for the planet

Abstract

Treated urban wastewater effluents may constitute a source of nutrients for the growth of bioplastic (polyhydroxyalkanoate, PHA) producing photosynthetic organisms. PHA are the only bioplastics that can fully biodegrade under all possible of environmental conditions. Currently, commercial PHA production process is undertaken by cultures of heterotrophic microorganisms with high demands of energy, substrates and clean high-quality water. While integrating PHA production into wastewater treatment has been suggested, this has not yet been achieved due to instability of the process.

In the present project, we propose a new approach to bioplastics production using cyanobacteria in the form of microbiomes which will be grown in treated urban wastewater taking the advantage of the residual nutrients contained within.
We will develop a production system by creating a new process engineering setup with intermediate separation and concentration step by using ultrafiltration membranes. Moreover, the system will be monitored with a fasttracking microbial community analysis tool based on flow cytometry to maintain cyanobacterial microbiomes stable in the highly variable treated wastewater environment. The treated wastewater, the culture's mixed liquor and the PHA will be analyzed and evaluated for micropollutants. Quantitative analytics (metabolomics and proteomics) and molecular biology methods (transcriptomics) will be applied to gain fundamental insight into PHA metabolic regulation mechanisms for the success of PHA production.
Different physical cell disruption techniques will be combined with environmental friendly solvents, such as natural deep eutectic solvents, for testing and developing a green PHA extraction and purification strategy.

This project is unique in that we aim to produce different PHA products with programmable biodegradability by embedding plastic-degrading bacteria within the bioplastic itself. We will assess the environmental, social, and economic impacts of the PHA production system to facilitate its upscaling and future implementation.

The stakeholders and end-users identified through the partners' networks will play an active role in shaping the project's challenges, problems and market uptake analysis. The process that we propose eliminates the need for aeration, high substrate and high-quality water demands of the commercial PHA production, and instead utilizes sunlight, captures CO2 and produces O2 . This process will contribute to recovery resources from water, will expand the current applications of water reuse and will allow to shift the existing paradigm of bioplastics manufacturing, rendering it inherently circular.

Project coordinator

Joan GARCÍA SERRANO - UNIVERSITAT POLITÈCNICA DE CATALUNYA - SPAIN

Project partners

- HELMHOLTZ-ZENTRUM FÜR UMWELTFORSCHUNG GMBH - GERMANY
- NOVA SCHOOL OF SCIENCE AND TECHNOLOGY - PORTUGAL
- SILESIAN UNIVERSITY OF TECHNOLOGY - POLAND
- UNIVERSITÀ DEGLI STUDI DI MILANO - ITALY
- UNIVERSIDADE FEDERAL DO ABC - BRAZIL

Funding organisations

AEI (SPAIN) / BMFTR (GERMANY) / FCT (PORTUGAL) / NCBR (POLAND) / MUR (ITALY) / CONFAP (BRAZIL)

Duration

3 years

Contact

Joan GARCÍA SERRANO
joan.garcia@upc.edu

KEYWORDS

water reuse,
bioplastics,
PHA,
cyanobacteria,
circular economy