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A new process with zero emissions for truly biodegradable plastics

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INTRODUCTION

The widespread use of petrol-based plastics has led to an environmental problem, as these materials are prone to abandonment, breaking down into microplastics and nanoplastics that harm living organisms. While biodegradable plastics are seen as a solution, their global production still remains modest at 1.3 million tons in 2022 (vs. 400 million tons of petrol-based plastics)[1]. Moreover, many such plastics fail to biodegrade efficiently under all environmental conditions (marine, soil, rivers, etc.)[2].

Polyhydroxyalkanoates (PHA) are a type of bioplastics naturally produced by microorganisms. They are a promising alternative because they degrade completely in soil, water, and marine environments. However, their industrial production is still limited and needs further research and investment to scale up.

Commercially produced PHA is nowadays highly energy-intensive and relies heavily on organic raw materials and clean water, which conflicts with the EU's goals for a circular, sustainable economy. The current production process is far away from the zero emissions neutral carbon strategy. The EU Horizon 2020 **PROMICON project** has developed an innovative method that uses photosynthetic microorganisms (cyanobacteria) to produce PHA efficiently. This process uses sunlight, absorbs CO_2, and requires minimal organic resources, aligning perfectly with EU bioeconomy goals.

EVIDENCE AND ANALYSIS

The PROMICON project has made significant progress in green PHA production:

- Demonstrated **continuous PHA production** over 100 days using cyanobacteria, overcoming the short timescales of previous studies[3].
- Discovered that PHA production occurs in two phases (growth and accumulation), opening the door to **scaling up the process**[4].
- Developed methods to **convert CO_2 directly into bioplastics**, reducing the need for plant-based sugars and fertilisers used in conventional production.

This process eliminates the need for aeration (a major energy cost), captures 2 kg of CO_2 per kg of biomass, and creates a truly biodegradable plastic alternative that leaves no microplastic residues.

POLICY IMPLICATIONS AND RECOMMENDATIONS

To support the development of this groundbreaking technology, we recommend the following actions:

- **Increase funding** for research on cyanobacteria-based PHA production to scale it up for industrial use.
- **Incentivise industry** adoption by creating certifications and labels for PHA products.
- **Encourage applications** of PHA in sectors prone to plastic waste, such as agriculture.
- **Raise awareness** through educational campaigns about PHA's environmental benefits.
- **Establish global standards** for biodegraadability testing by fostering international collaboration.

PROJECT OBJECTIVES AND METHODOLOGY

The PROMICON project aims to understand microbiome functionality to steer their phenotypes for producing biopolymers, energy carriers, feedstocks, and antimicrobials. It focuses on analysing key species and whole microbiomes using advanced data mining, modelling, and machine learning. PROMICON integrates synthetic biology and metabolic engineering to optimise microbial communities for efficient metabolite production. The project establishes a standardised platform for quantitative single-cell and OMICS data analysis. Its outcomes align with the EU bioeconomy strategy, promoting sustainable bioproducts and the circular economy.

SUSTAINABILITY AND LEGACY

Cyanobacteria-based PHA production aligns with key sustainability goals:

- **Reduces plastic pollution** by producing fully biodegradable plastics.
- **Cuts CO_2 emissions** by using photosynthesis to convert CO_2 into useful materials.
- **Promotes resource efficiency** by reducing dependence on fossil fuels and agricultural inputs.

This innovation supports a transition to sustainable bioplastics, reduces environmental damage, and creates green jobs, positioning the EU as a leader in the bioeconomy.

REFERENCES

1. European Bioplastics e.V. 2022. Accessed November 19th, 2024. https://www.european-bioplastics.org/
2. Narancic, T., Verstichel, S., Reddy Chaganti, S., et al. (2018). Biodegradable Plastic Blends Create New Possibilities for End-of-Life Management of Plastics but They Are Not a Panacea for Plastic Pollution. *Environ Sci Technol*., 52(18):10441-10452. https://doi.org/10.1021/acs.est.8b02963
3. Altamira-Algarra, B., Lage, A., Meléndez, A.L., Arnau, M., Gonzalez-Flo, E., García, J. (2024). Bioplastic production by harnessing cyanobacteria-rich microbiomes for long-term synthesis. *Sci Total Environ*., 954: 176136. https://doi.org/10.1016/j.scitotenv.2024.176136
4. Altamira-Algarra, B., Lage, A., García, J., Gonzalez-Flo, E. (2024). Photosynthetic species composition determines bioplastics production in microbiomes: Strategy to enrich cyanobacteria PHB-producers. *Algal Res*.:103469. https://doi.org/10.1016/j.algal.2024.103469

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