Bioplastic (poly-3-hydroxybutyrate) production by the cyanobacteria Synechocystis sp. growing in wastewater

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Polyhydroxybutyrate (PHB) is a polymer synthesized by microorganisms and is of interest as a biodegradable plastic alternative (e.g., in the packing industry) because of its ability to completely degrade into water and carbon dioxide under natural environmental conditions without using any industrial facilities.

The aim of this work was to develop an eco-innovative technology for the production of bioplastics in cyanobacteria that uses nutrients from wastewater. This work addresses two essential areas of human activity: a new alternative way of producing bio-based degradable plastics by reusing waste.

Wastewater from urban treatment plant and wastewater from dairy products were tested as potential substrates. Nutrients recovered from wastewater were used to grow *Synechocystis* sp. PCC6714 Mt_a24, a cyanobacteria strain generated by UV mutagenesis with an enhanced PHB production. The strain was cultivated in a thin-layer hybrid raceway pond with a working volume of 100 liters, reaching a biomass density of up to 3.5 g L^{-1} of cell dry weight (CDW) in urban wastewater. The maximum PHB content was achieved in the late stationary phase under nutrient-limiting conditions, reaching 23.7 ± 2.2 % PHB per CDW. To our knowledge, these results are the highest ever reported for photosynthetically produced PHB by cyanobacteria utilizing wastewater in mass cultivation, highlighting the potential of sustainable cultivation approaches. Furthermore, the strain MT_a24 demonstrated significant nutrient removal up to 71.8% of nitrogen and 67.4% of phosphorus.

Cultivation in dairy wastewater was carried out in a closed annular photobioreactor. It was possible to grow biomass up to a density of 2-2.5 g/L, with a 10% PHB content per CDW.

One of the major problems in mass culture - the presence of predators - was solved by culturing Synechocystis in a highly alkaline environment (pH≈10.5) in both cultivations without significantly affecting the culture's physiological status.