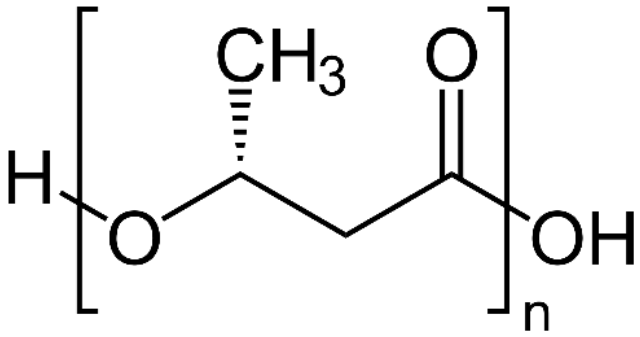
PlastoCyan – Interreg ATCZ 260

Motivation

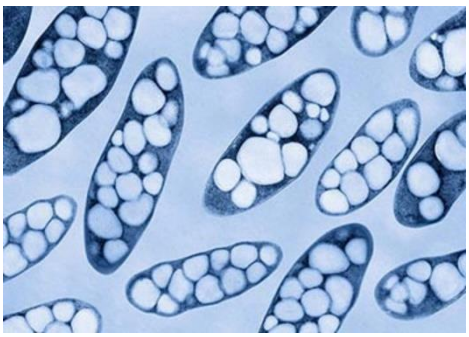


Polyhydroxybutyrate (PHB) is used for coatings in textile industry, for packaging or for medical applications. PHB-blends are also used in adhesive, hard rubber and more.

PHB characteristics:

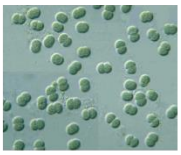
- = polyhydroxyalkanoate (PHA)
- **Hydrophobic** properties
- Bio-derived and biodegradable plastics
- **Water-insoluble** and **resistant to hydrolytic degradation**
- Soluble in chloroform and other chlorinated hydrocarbons
- Similar charactersitics to polypropylene (PP)

The state of the art for PHB production is a not carbon neutral process, where *Cupriavidus necator* (*Ralstonia eutropha)* is cultivated on organic carbon. This process emits CO_2. Additionally, currently used PHB extraction is done by organic solvents, such as chloroform, as precipitation agent. A green alternative is required! Up to today, there is no possibility to fixate carbon during PHB production and the extraction has no regeneration steps and works with toxic solvents.

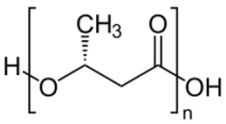


Hypothesis and approach

Dairy Wastewater



Synechocystis sp.

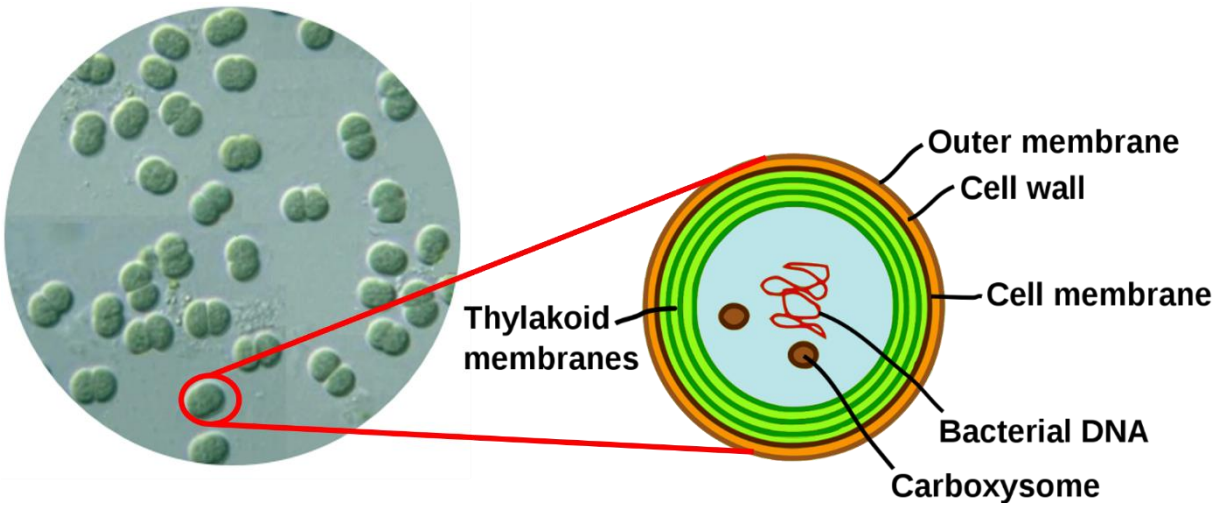


Polyhydroxybutyrate - PHB

To address the above-mentioned challenges, we have three hypotheses:

1) a **modified *Synechocystis* sp. strain** can **metabolize lactose** from dairy wastewater and utilize the waste stream as organic **carbon source (FH OÖ, Wels Austria)**
2) the cultivation of that **modified *Synechocystis* sp. strain in a pilot scale** results in a large amount of PHB produced **(Algatech, Trebon Czech Republic)**
3) **Ionic liquids** are suitable for a **non-toxic, sustainable** extraction process, compared to the state of the are chloroform extraction **(TU Wien, Vienna Austria)**

The single cell cyanobacteria ***Synechocystis* sp. can therefore contribute to renewable, sustainable PHB-production. The cultivation is possible in three modes:** phototrophic, mixotrophic and heterotrophic. Glycogen and PHB act as storage substances.



Cultivation modes:

Phototroph

- → Photosynthesis
- → With illumination
- → CO_2 Uptake
- → O_2 Production

Mixotroph

- → Photosynthesis
- → With illumination
- → Waste metabolisation (organic carbon uptake)
- → CO_2 uptake

Heterotroph

- → Darkness
- → Waste metabolisation (organic carbon uptake)
- → No photosynthesis = No CO_2 uptake

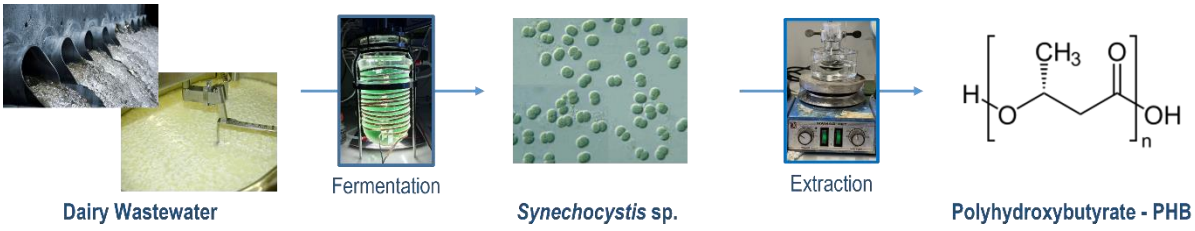
Ionic liquids are a green alternative to chloroform. They are recyclable and therefore decrease the environmental footprint. This contributes to green bioplastic production and circular economy.

Goal

We want to utilize wastewater for the production of *Synechocystis* sp. Biomass and:

- → Establish a **CO_2 neutral** production process for PHB production
- → Determine cultivation parameters for **maximal PHB output**
- → Find a **sustainable approach for the extraction of PHB** from cyanobacterial biomass

Towards a green PHB production and extraction process!



Project Partners

Lead Partner: Institute of Microbiology CAS - MBU Algatech Center (Trebon, Czech Republic)

The Czech partner MBU has the main responsibility for project implementation, achievement of the tasks and communication with the joint secretariat. The main benefit of the whole project is an eco-innovation, which can be used for industrial applications to produce PHB in cyanobacteria by adding various wastewaters. This PHB can then be used as bioplastic in various applications. The specialization of the partners is very complementary and essential for achieving the goals and results.

The MBU has extensive experience in the cultivation of phototrophic microorganisms (cyanobacteria and algae) in different cultivation scales and the pre-treatment of municipal wastewater. Therefore, the MBU is responsible for the analysis of wastewater and the optimization of the cultivation process with wastewater and the used cyanobacteria strain.

Project Partner: FH OÖ (Wels, Austria)

FH OÖ has experience in genetic engineering and molecular biology as well as in the genetic modification of cyanobacteria, which are essential for the utilization of dairy wastewater and the increase of PHB production. FH OÖ is thus responsible for the production of new and genetically modified cyanobacterial strains.

Collaboration

The synergy of the competences will enable the project objective to be achieved: the MBU determines the basic conditions necessary for the cultivation of cyanobacteria in the different wastewaters (analysis of the wastewaters, determination of the tolerance of the cyanobacteria against the different ingredients) in order to produce PHB from it, which can be used for bioplastics production. At the FH OÖ, cyanobacteria strains are produced that show an increased PHB production and can also utilize the residual substances from the dairy. At the TU Wien, the cyanobacteria generated by FH OÖ will be selected for PHB production and the best producers will be sent to the MBU in the Czech Republic. There they will be cultivated on a large scale under the previously determined conditions to produce biomass. This biomass will be sent to the TU Wien, that will develop a method for PHB extraction from the biomass.

Project Budget – financed from the European Union

335 365,62€

Project Duration

01.06.2021 – 31.12.2022

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