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# Waste to Value – technology to transform waste streams into valuable products

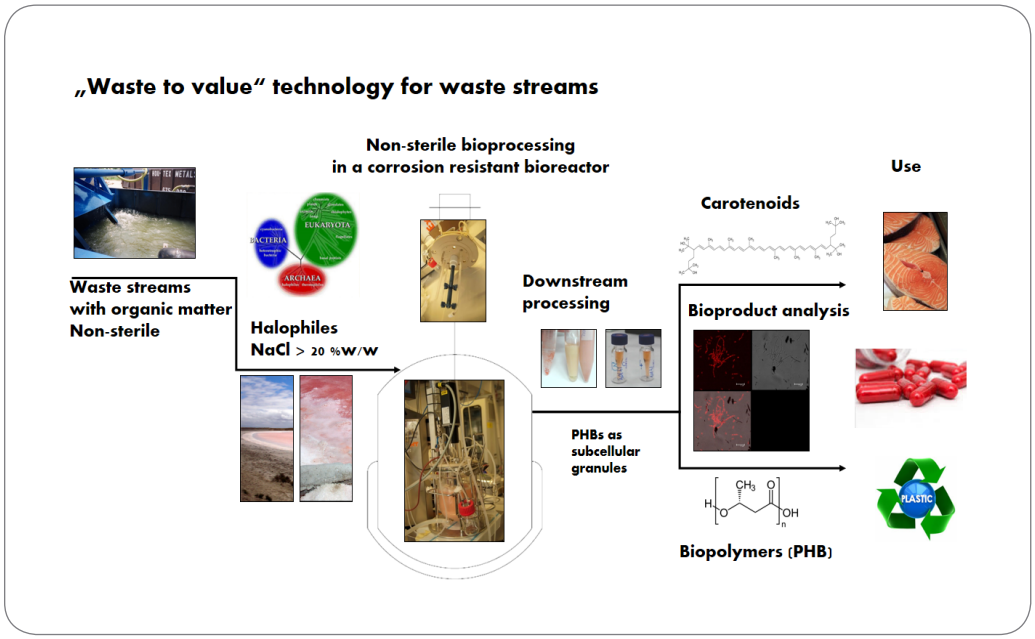
## Production of valuable bio-products from waste streams with organic content

### Objectives and mission

Waste streams of diverse industrial processes are often rich in organic carbon, their disposal or recycling can be therefore complex and expensive. The novel technology enhances economic viability of these production processes through process intensification by stream couplings, i.e. waste recycling and further use of the organic content for value added bio-product productions. Our mission is to contribute to process intensification by not only performing energy integration but also coupling different streams in the framework of the bio-refinery concept with "waste to value" principles.

### Approach

Halophilic microorganisms are capable of growing on a wide variety of carbon sources under non-sterile conditions. They are able to live on organic acids, diverse sugars, the sugar alcohol glycerol and even aromatic compounds, also among others. And they are producing secondary metabolites like carotenoids or biopolymers. In addition, they can even produce recombinant products. Halophiles allow for easy down-streaming of intracellular products, as disruption of cells occurs automatically in water due to osmotic shock.




Transformation of >95% organic content of waste streams into valuable products, like carotenoids or biopolymers – e.g. for use in food- and pharmaceutical industry or packaging and plastics indusry

Quantitative bioprocess development in laboratory scale was performed on synthetic defined medium for modeling waste streams of different chemical composition, with the identification of the kinetics, stoichiometry, bio-product portfolio, maximal productivity with special attention to the critical parameters, affecting scale-up . The quantitative bio-processing technology is based on defined medium and - as salt has to be added to the waste stream - in a corrosion resistant bioreactor.

## Results

Physiological characterization of halophiles in bioreactors - A corrosion resistant bioreactor setup for extreme halophiles has been implemented. With providing defined and controlled cultivation conditions in the bioreactor, for the first time, quantitative data on stoichiometry and the kinetics were collected and evaluated on different carbon sources. The used carbon sources also have relevance since they are common residues in industrial waste streams. With proposing metabolic mechanisms, the results on various substrates were interpreted by linking to the reported primary carbon metabolism of extreme halophiles.

Halophilic bioproduct portfolio - Extreme halophiles are known to produce a variety of lipophilic compounds which may also be valuable natural products with many possible applications from food colouring agents to anticancer materials. The main compound of the carotenoid content of extreme halophilic Archaea is bacterioruberin, an acyclic C50 carotenoid with four hydroxyl groups.

Produced by extreme halophlies, poly-hydroxybutyrate (PHB) is a polymer synthesized intracellularly and stored as carbon and energy reservoir. The interest in PHB has been due to its unique characteristic of being a biodegradable thermo-polyester with properties similar to those of petroleum derived plastics. The PHB production of some halophilic strains was evaluated on waste streams along our experimental work.

Productivity - High biological activity and volumetric productivity are considered as prerequisites for efficient bioprocesses, extreme halophiles have, however, lower growth rates. To overcome this physiological limit and to achieve increased volumetric productivity, the produced biomass must be retained in a bioreactor, for example equipped with an external cell retention system. In our work, the characterization and parameterization of a bioreactor setup with cell retention was carried out with focussing on maximizing the volumetric productivity; 10-fold productivity increase was achieved compared to continuous cultures.

Real-medium applications - Exploiting the benefits of controlled bio-processing of extreme Halophiles, a pending patent application of TU Wien proposes the use of Halophiles for biological conversion of the waste stream from bio-hydrogen production with small metabolites to high value added products. Hence, the potential biotechnological applications with Halophiles can cover wide ranges of intelligent process intensification solutions "waste to value", valuable bio-product production with halophilic microorganisms on any kinds of waste streams with organic content.

## Benefits

- Halophiles can generate extra valuables on diverse industrial waste streams
- More than 95% of the organic content of the waste stream can be removed and transformed into valuable products
- Easy down streaming of intracellular products
- The non-sterile process can be implemented in any industrial environment
- Scalability given through defined medium und the use of bioreactor with controlled and defined cultivation condition

### Potential applications

- Process intensification for industrial waste streams rich in organic carbon
- The process can be coupled with anaerobic fermentation broths like in bio-hydrogen production
- Fully functional also for waste streams with high pH value or salt content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