**Algae4Cycle - Exploiting microalgae biotechnology to treat industrial process waters with extremophilic species**

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**Highlights**

* Industrial wastewater is treatable with microalgae
* Extremophiles exhibits great potential for process water treatment.
* Nitrogen and carbon load can be reduced significantly
* Process heat can be used economically senseful

**1. Introduction**Process waters from food and bioenergy industries commonly exhibit a high load of organic (e.g. sugars) and inorganic (e.g. nitrate, phosphate) residues. The disposal of such process waters is a financial burden for the companies due to high disposal fees or the need to build up an own sewage plant.   
In this context, microalgae provide an promising option for wastewater treatments due to their metabolic flexibility, i.e. the ability to metabolize a great variety of organic and inorganic compounds at phototrophic, heterotrophic or mixotrophic growth, coupled with the production of valuable metabolites like fatty acids, proteins or natural pigments. Exemplarily work can be found in literature: The treatment of food waste with *Chlorella pyrenoidosa* and *Schizochytrium mangrovei* showed satisfying growth rates and stable nutrient degradation [1]. *Nannochloropsis* sp. was also used to treat industrial wastewater emitted by an oil refinery, which contains environmental challenging components like cyanide, sulphat and ammonium formate [2]. The wastewater coming from an olive mill was used to produce *Scenedesmus* sp. biomass. [3] There are a lot more published processes using microalgae, for piggery wastewater [4], carpet mill effluents [5] or paper industry wastewaters [6]. A problem for all these approaches is to maintain the axenity of the cultures.   
The use of extremophilic strains reduces the probability of contaminations with other microorganisms, caused by their very selective growth conditions. Thus, the project Algae4Cycle aims on the design of a modular on-side plant for treating specifically industrial process waters with high sugar contents using mono- or co-cultures of extremophilic microalgal strains.  
**2. Methods**

First, suitable strains were collected focusing on the utilization of carbon and nitrogen in wastewater-relevant concentrations. Therefore, extremophilic species out of Chlorophyta and Rhodophyta are investigated and their degradation capability and growth capacity is quantified. The growth on different carbon and nitrogen sources is investigated in order to create a database of the metabolic properties of the extremophilic strains.   
*Galdieria sulphuraria* naturally exist in hot thermal springs and is capable of handling harsh conditions like high concentrations of sulfuric acid or temperatures above 50 °C. *G. sulphuraria* is known for its capability to produce phycocyanin, a blue pigments with high economic value. There are already approaches that show promising results by using *G. sulphuraria* treating urban wastewaters in field scale[7].   
*Pumiliosphaera acidophila* is found in mine-impacted environments with high concentrations of transition metals. It grows optimally at pH 2,5 and 30 °C [8] and is therefore a good candidate for acid-containing wastewaters. Another acidophilic candidate is *Clamydomonas acidophila* which grows optimal at pH 2,5 and offers a high content of lutein [9].   
In addition to thermophilic strains there are species which shows a psychrophilic behavior. *Koliella antarctica* was found in the Antarctic sea at temperatures of -1,5 °C. Cultured at 10 to 15 °C *K. antarctica* shows a great accumulation of lutein and astaxanthin [10].   
Since not all of the aforementioned microalgal strains were studied regarding the metabolization of organic substrates, growth characteristics using typical organic wastewater constituents were analyzed in this study.   
**3. Results and discussion**In this study we characterize the spectrum of usable energy sources for growth and assess the capacity for degrading substances arising in common industrial processes. We developed an on-site plant concept, for flexible use with different wastewater compositions and characteristics. Produced process-based waste heat is used for reducing the energy costs of the system and cleaned wastewater is recycled for reuse in producing processes. The aim is, to close the energy and material cycle and gain valuable algae-based by-products.

**References**

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