Cost efficient algal cultivation systems – A source of emission control and industrial development (MICROALGAE).
Period covered: 01.02.2015 – 31.01.2016

"This work resulted from the BONUS Microalgae project was supported by BONUS (Art 185), funded jointly by the EU and the Estonian Environmental Investment Centre (KIK), The Danish Agency for Science, Technology and Innovation (DASTI) and The Swedish Foundation for Strategic Environmental Research (MISTRA)"

The project's overall aim

BONUS-MICROALGAE project aims at providing innovative solutions for the use of microalgae species for removal of nutrients and micro-pollutants in wastewater coupled with further use of biomass.

The project activities performed during the second reporting period

1. Development and optimization of single-stage continuous photo-bioreactor system with constant light supply and controlled temperature by cultivating selected algal culture (*Chlorella sorokiniana*) in mixed industrial/municipal wastewaters.
2. Assessment of the efficiency of microalgae for wastewater treatment.
3. Characterization of microalgal biomass for possible utilization.
4. Scaling up analytical parameters in order to determine the sustainability of the entire technological process.
5. Dissemination of the results and project management including project meetings and reporting.

Results

1. The lowest dilution rate provided the highest biomass concentration up to 1.44g l^{-1}. Based on the fitting curve obtained from four measured points, the productivity peak was estimated to be 1.52 g $l^{-1}d^{-1}$ at the dilution rate of 2.41 d^{-1}. The highest removal efficiencies (> 90%) of pollutants were also observed at the lowest dilution rate. However, the removal of COD for all dilution rates was only around 50%. The removal efficiencies of zinc at different dilution rates varied considerably being more than 30% at the lowest dilution rates (Deliverable 2.1).

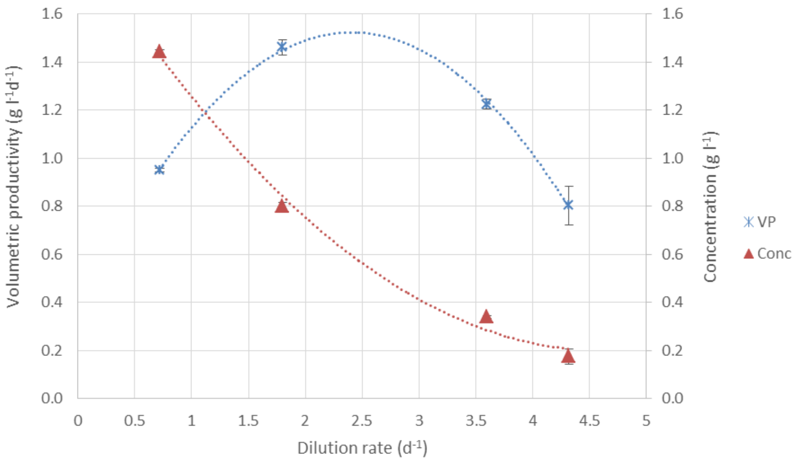

Figure 1: Effect of dilution rates on cell concentration and volumetric productivity

2. The treated wastewater was compared with the composition of untreated wastewater. The analysis of COD, TN, TP, NH4-N and zinc were performed after the treatment process. The treatment efficiencies by microalgae are presented in Figure 2.

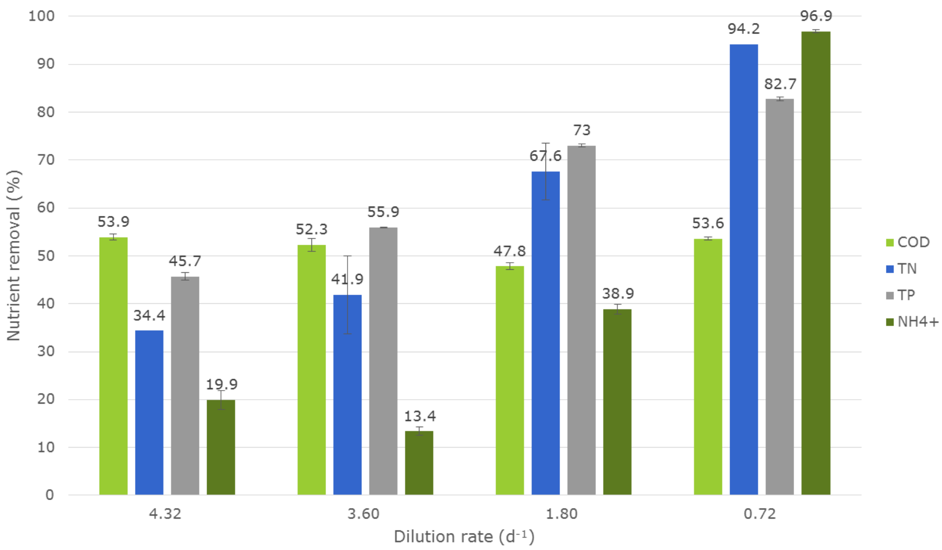

Figure 2: Effect of dilution rates on nutrient removal efficiencies

Removal efficiencies of zinc at different dilution rates (e.g. retention time) varied considerably. The removal efficiencies at the lowest dilution rates of 0.72 and 1.80 d^{-1} were about 30%. The dilution rate 1.8 d^{-1} appeared to be optimal, both for the biomass production and for the removal of nitrogen and phosphorus from wastewaters. The higher removal efficiencies of the zinc were also observed at the lower dilution rates (Deliverable 2.2).

3. The average yields of FAME, protein, lutein, chlorophylls and β-carotene were 62.4 mg, 388.2 mg, 1.03 mg, 11.82 mg and 0.44 mg, respectively. Furthermore, pigment yields at three dilution rates (4.32 d-1, 3.6 d-1 and 1.8 d-1) did not show significant change. The biomethane potential measured for the microalgal biomass corresponded to 323±63 ml CH4/g-VS (Deliverable 2.3).

4. When upscaling the lab scale data, this cultivation strategy resulted to be uneconomical. The maximum potential annual revenue was estimated to be more than two times lower than the production cost that took in consideration only basic utilities. The economic potential analysis revealed that more than 80% of revenue could be obtained from the production of pigments, as well as from reduction in discharging cost of the treated wastewaters (23%). Significant contribution to the overall profit was generated by the removal of N and P from the wastewater. Power consumption for artificial light was responsible for the majority of production cost. Avoiding the use of artificial light could reduce the production cost by 94% (Deliverable 2.4).
The obtained results in Deliverable 3.1 suggested that local variations on incoming wastewaters, as well as economies of scale and economies of scope in individual WWTPs affect optimal conditions for the adoption of microalgae as an abatement technology.

5. The dissemination activities included publication of a popular scientific report (Deliverable 5.3) and introducing the results in scientific conferences and other collaboration activities. To increase the wider societal implications of project results all deliverables were uploaded to project official website.