

POLIS_MSCA-IF-661429_DATASET-1

Project: POLIS

Marie Skłodowska-Curie Individual Fellowships

MSCA-IF-2014-EF

GA No. 661429



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Dataset name	POLIS_MSCA-IF-661429_DATASET-1
Grant number	661429 - POLIS - H2020-MSCA-IF-2014
Project number	661429
Project acronym	POLIS
Project title	Studying the bricks of microbial cities: characterization and structural properties of exopolysaccharides and their interaction with proteins and cations in anammox granular sludge
Call (part) identifier	H2020-MSCA-IF-2014
Topic	MSCA-IF-2014-EF Marie Skłodowska-Curie Individual Fellowships (IF-EF)
Fixed EC Keywords	Environmental biotechnology, bioremediation, biodegradation
Free keywords	anammox, granular sludge, biofilm, exopolymeric substances, exopolysaccharides, EPS, rheology, exopolymeric proteins, mono-divalent cations
Beneficiary	Polytechnic University of Milan (PIC: 999879881)
Department	Department of Civil and Environmental Engineering (DICA)
Supervisor	Prof. Francesca Malpei
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Project description	This research project is in the context of environmental engineering, in particular in the field of wastewater treatment, more specifically focused on biofilm-based innovative technologies for nitrogen removal. The anaerobic ammonium oxidation (anammox) bacteria are recently discovered players of the biogeochemical nitrogen cycle. The bioprocess based on anammox metabolism is an innovative technology



for the removal of nitrogen from municipal and industrial wastewaters allowing important savings on operational costs due to the requirement of 60% less oxygen (aeration), no need for organic carbon and the production of 90% less excess sludge, compared with conventional nitrogen removal technologies. Its potential application to municipal wastewater (sewage) would allow a complete redesign of the present energy-consuming into an energy-yielding sewage treatment plant. Due to the slow growth rate of anammox bacteria, their retention in the system is one of the main concern for process stability. This is the reason why in most of the different anammox-based technologies currently applied, anammox bacteria are cultivated in the form of biofilm and in particular in the form of self-aggregating biofilm (i.e. granular sludge). Biofilm stability is closely related to the properties of the extracellular polymeric substances (EPS) constituting the matrix in which microorganisms live and grow. EPS are high-molecular weight compounds secreted by microorganisms establishing the functional and structural integrity of biofilms, and are considered the fundamental component that determines the physiochemical properties of a biofilm. EPS are mostly composed of polysaccharides and proteins, but also include other macro-molecules such as DNA, lipids and humic substances. The aim of the present research was to investigate the structural components of anammox EPS matrix unrevealing the mechanisms involved in anammox biofilm (specifically granular sludge) formation and stability. Several extraction methods were tested to evaluate the extraction yield and the total carbohydrates/protein content. Mass spectrometry (e.g. MALDI MS) was used to investigate functional EPS and their fine structures, with special focus on hydrogel and film forming components. Rheometric analysis were used to evaluate the viscoelastic characteristics of anammox granular sludge in comparison with the hydrogel (potentially) formed by extracted EPS and their interaction with mono/divalent-cations. Microscopy techniques (mainly AFM, SEM) were used to image the morphology of the extracted biopolymer and the film structure.

Considering that excess sludge is currently one of the main waste products of wastewater treatment facilities, the recovery of a bio-based polymer and its application in other industrial sectors would contribute to the transition towards a circular economy fostering sustainable economic growth. The results of the present research could identify the potential applications of a bio-based polymer recovered from excess biofilm sludge based on its properties.

Open access to scientific publications and underlying data

Scientific peer-reviewed publications such as journal articles will be deposited upon publication in Zenodo repository (<https://zenodo.org/>), an OpenAIRE/CERN repository. The deposition of the research data needed to



validate the results presented in the deposited scientific publications ('underlying data') will be evaluated from time to time by the Researcher (Ing. Tommaso Lotti, PhD) and the Supervisor (Prof. Francesca Malpei) along the project development according to the approach of the European Commission “as open as possible, as closed as necessary”. The research data decided to be open up will be organized in separate data sets. For the description of each data set and the relative depositing procedure, the reader is referred to the “DATA SETS” section below. The list of openly shared data sets will be updated and/or modified whether necessary during the time course of the project.

DATA SETS

Data set name POLIS_MSCA-IF-661429_DATASET-1

Data set description Different protocols used to extract structural extracellular polymeric substances (EPS) from anammox granular sludge.

EPSs were extracted from freeze-dried anammox granules originating from the full-scale anammox reactor of the wastewater treatment plant of Rotterdam, Sluisjesdijk-Dokhaven (van der Star et al., 2007). EPS were extracted by the following methods: ultrasonication, heating with Na_2CO_3 , cations exchange resin, ethylenediaminetetraacetic acid (EDTA), NaOH, formamide with NaOH, formaldehyde with NaOH, sulfuric acid. The related parameters and procedure were modified based on previous studies (Felz et al. 2016; Wang et al. 2014). A schematic representation of the methods applied is reported in Figure 1.

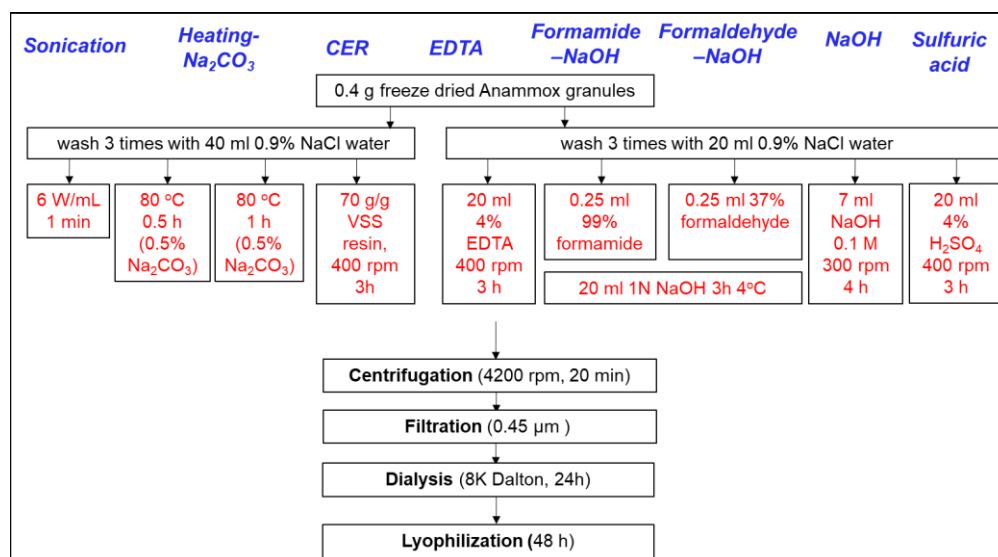


Figure 1. Schematic representation of the different extraction methods applied.



The extraction efficiency of each protocol was evaluated by the following parameters:

- Extraction yield evaluated by gravimetric analysis
- Carbohydrates and protein equivalent content of the EPS resulting from different extraction protocols

Tests were conducted in triplicates. Dataset will be presented in the form of tables and saved in pdf format with the name “POLIS_MSCA-IF-661429_DATASET-1.pdf”.

Standards and metadata

Extraction protocols were derived from biofilm literature and in particular from biofilm systems applied in the field of wastewater treatment.

Gravimetric analysis according to American Public Health Association (APHA), Standard Methods for the Examination of water and Wastewater (2005). Data are expressed as milligrams of extracted-EPS dry weight per gram of volatile suspended solids (VSS) of the original biofilm (mg-EPS/g-VSS).

Total carbohydrate content was determined by a phenol-sulphuric acid assay with D-glucose used as standard (Dubois et al., 1956). Data are expressed as milligram of total carbohydrates as D-glucose equivalent per gram of extracted-EPS dry weight (mg/g-EPS).

Protein content was measured by the biconchonic acid (BCA) protein assay with bovine serum albumin (BSA) used as standard (Interchim Uptima BC assay quantitation kit). Data are expressed as milligram of total proteins as BSA equivalent per gram of extracted-EPS dry weight (mg/g-EPS).

To the best of author knowledge Metadata standards are missing in this particular field. Therefore, our results were reported using acronym and units of measurements according to the most renowned journals in the field (e.g. Water Research, Environmental Science and Technology, Bioresource Technology, etc.). In order to facilitate data sharing and use, metadata describing the nomenclature used for the storage of research data is given in a separate text file named "DATASET-1_metadata" in .pdf format. The file "DATASET-1_metadata" contains the list of acronyms and symbols used for data presentation as well as the description of the materials and methods used during the experimental phase.

Data sharing

A selection of research data will be deposited, upon publication of the scientific publication reporting the elaborated research data, in Zenodo



repository (<https://zenodo.org/>), an OpenAIRE/CERN repository. Zenodo provides to each data set a persistent identifier (DOI).

Peer-reviewed scientific publications will be deposited in self archiving/green "OA" repositories such as Tommaso Lotti's page on ResearchGate (https://www.researchgate.net/profile/Tommaso_Lotti) and Polytechnic University of Milan institutional self-archiving system (<https://re.public.polimi.it/>).

Research data as well as scientific publications and conference papers are available upon request via e-mail.

References

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