N°929 / PC
TOPIC(s) : Waste valorization / Polymers

Polyhydroxyalkanoates from sewage sludge: the B-PLAS proof of concept

AUTHORS
Chiara SAMORÌ / UNIVERSITY OF BOLOGNA, VIA SANT'ALBERTO 163, RAVENNA

PURPOSE OF THE ABSTRACT

Approximately 40% of chemical energy of food ends up in wastes or in wastewater. Wastewater treatment (WWT) is unequivocally associated to the production of a large amount of sewage sludge, that requires suitable and environmentally accepted management before final disposal. The amount of sewage sludge produced in 2005 by the 27 EU Member States was about 11 Mton of dry matter (1). This material can be subjected to anaerobic digestion (AD), valorizing about one third of its chemical energy and producing a scarcely biodegradable digestate (WWT sludge). WWT sludge is currently disposed of in land (56%), incineration (27%) or landfilling (17%), with greenhouse gas emissions, potential biohazards and variable disposal cost (5 ? 120 ?/twet). To date, final disposal strategies neglect the potential use of sludge as feedstock for the production of value-added materials. B-PLAS DEMO project (funded by EIT-climate KIC) aims at exploiting the chemical potential of WWT sludge for producing polyhydroxyalkanoates (PHAs) (Figure 1). PHAs are biodegradable/biocompatible linear polyesters that today cover a niche in the field of bioplastic market (around 2.5% of biopolymers globally produced), mainly because of the non-competitive process costs (5-6 ?/kg) if compared with other bio-based/biodegradable plastics (2). B-PLAS DEMO project goal is solving this economical bottleneck by applying an integrated approach in which an initial hydrothermal carbonization (HTC) pre-treatment (150 ? 250°C) of WWT sludge is followed by a sequence of biological/chemical processes: i) acidogenic fermentation for converting HTC products into volatile fatty acids (VFA), ii) pertraction of VFA, and iii) aerobic conversion of VFA into polyhydroxyalkanoates (PHAs) through microbial mixed cultures (MMC).
This communication reports the preliminary results of the entire process that will be scaled up to 1 kton/y of PHA in the B-PLAS DEMO project. Among the various HTC conditions tested (temperature and time), a treatment at 200°C for 60 minutes allows to increase by 10 times the soluble chemical oxygen demand (COD) of WWT sludge, allowing to split 44-54% of its COD into an aqueous phase (HTCap) enriched in small fermentable organic molecules. Acidogenic fermentation of HTCap converts these substrates into VFA (20% of CODHTCap), subsequently transferred in an aerobic reactor through a trioctylamine-biodiesel liquid membrane in an ad-hoc designed pertraction system. MMC convert VFA into PHA (20% of CODVFA). Finally, the extraction of microbial biomass with pressurized dimethyl carbonate (DMC) allowed to produce high quality PHA, with a high molecular weight (0.9 MDa) and a percentage of medium chain monomers (hydroxyvalerate and hydrohexanoate) close to 12%.

Reference
1. Kelessidis, A.; Stasinakis, A.S. Waste. Manag. 2012, 32, 1186-1195.
2. Kourmentza, C; Plácido, J; Venetsaneas, N.; Burniol-Figols, A.; Varrone, C.; Gavala, H. N.; Reis, M.A.M. Bioengineering. 2017, 4, 55.

FIGURES

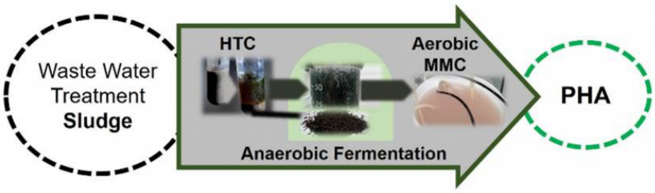

FIGURE 1

Figure 1

B-PLAS DEMO project concept: coupling thermochemical treatments and microbial fermentations to convert C-atoms and chemical energy of wastewater sewage sludge into PHA.

FIGURE 2

KEYWORDS

Sewage sludge | Polyhydroxyalkanoates | Hydrothermal carbonization | Microbial fermentations

---

BIBLIOGRAPHY

[1] Kelessidis, A.; Stasinakis, A.S. Waste. Manag. 2012, 32, 1186-1195.

[2]. Kourmentza, C; Plácido, J; Venetsaneas, N.; Burniol-Figols, A.; Varrone, C.; Gavala, H. N.; Reis, M.A.M. Bioengineering. 2017, 4, 55.