PhD School on Agriculture, Environment and Bioenergy

(http://sites.unimi.it/dottorato_aab/)

(XXXVIII cycle, 2022-25)

Project draft

1.Field of interest

*AGR13**: biomass recovery, circular economy, bioeconomy***

2.Project title

Improving the circularity of biodegradable bioplastics by producing biogas: a full-scale assessment

3.Tutor (membro del Collegio dei Docenti) Fabrizio Adani Gruppo Ricicla-DiSAA-University of Milano

Co-tutor/s:

4. Relevance of the topic and state of the art:

Plastic is a category of materials that comprises several synthetic polymers. Despite the usefulness and convenience of these materials, their production and end-of-life management pose a serious threat to the environment and living organisms, mainly due to green-house gases emission and environmental pollution.

In this context, bioplastics are gaining interest due to policies that impose bans on conventional single-use plastic items (European Parliament, 2019), and to the perception of being more environmental-friendly, making them the best alternative to conventional plastics. Today, bioplastics certified as biodegradable and compostable are collected within biowaste and thus, their disposal follows waste management strategies used for organic wastes (i.e., anaerobic digestion, composting or coupled anaerobic digestion and composting). Anaerobic digestion (AD) appears to be a promising strategy for bioplastics recovery, allowing energy production (biomethane), reducing C footprint, and making the circularity of these products real. In this context, the purpose of this work was to assess the anaerobic degradability of bioplastic and its role in increasing bioplastic circularity

5.Layout of the project (draft)

5.1. Materials & Methods:

Most common bioplastic will be studied both at pilot and full-scale AD plant to investigate their biodegradability. Test will be performed by using an innovative approach able taking data directly from full-scale plant. Chemical, physical approaches will be used to track bioplastic degradation and kinetic will be detected.

In parallel microbial-adapted population approaches will be developed using innovative approaches (self-adaptation). Metagenomic approaches and maybe microbial transcriptomics population will be used to assess population adaptation.

Raw environmental (LCA) and economical sustainability will be considered, too.

5.2. Schedule and major steps (3 years):

1) First year: Bibliography, experimental design set-up and first experimental work
3) Second year: experimental work performed at both lab and full scale studying bioplastic degradation and energy prodcution
2) Third year: data elaboration and raw environmental and economic sustainability studies, paper writing

6. Available funds. Fabrizio Adani-UNIMI**.**

6. Literature:

1. B. Zakaria e B. Dhar, «Progress towards catalyzing electro-methanogenesis in anaerobic digestion Abraham, A., Park, H., Choi, O., Sang, B.I., 2021. Anaerobic co-digestion of bioplastics as a sustainable mode of waste management with improved energy production – A review. Bioresource Technology. https://doi.org/10.1016/j.biortech.2020.124537
2. Bátori, V., Åkesson, D., Zamani, A., Taherzadeh, M.J., Sárvári Horváth, I., 2018. Anaerobic degradation of bioplastics: A review. Waste Management 80. https://doi.org/10.1016/j.wasman.2018.09.040
   Battista, F., Frison, N., Bolzonella, D., 2021. Can bioplastics be treated in conventional anaerobic digesters for food waste treatment? Environmental Technology and Innovation 22. https://doi.org/10.1016/j.eti.2021.101393
3. Cafiero, L.M., Canditelli, M., Musmeci, F., Sagnotti, G., Tuffi, R., 2021. Assessment of disintegration of compostable bioplastic bags by management of electromechanical and static home composters. Sustainability (Switzerland) 13. https://doi.org/10.3390/su13010263
4. Camacho-Muñoz, R., Villada-Castillo, H.S., Solanilla-Duque, J.F., 2020. Anaerobic biodegradation under slurry thermophilic conditions of poly(lactic acid)/starch blend compatibilized by maleic anhydride. International Journal of Biological Macromolecules 163. https://doi.org/10.1016/j.ijbiomac.2020.09.183
5. Cucina, M., de Nisi, P., Tambone, F., Adani, F., 2021a. The role of waste management in reducing bioplastics' leakage into the environment: A review. Bioresource Technology. https://doi.org/10.1016/j.biortech.2021.125459
   Cucina, M., de Nisi, P., Trombino, L., Tambone, F., Adani, F., 2021b. Degradation of bioplastics in organic waste by mesophilic anaerobic digestion, composting and soil incubation. Waste Management 134.