Production of eco-friendly multipurpose Biobased products from Municipal Bio Waste (MBW) – LIFE EBP project

F. Liendo[1], S. Solaro[1], Massimiliano Antonini[1], Enzo Montoneri[1]

[1]Hysytech Srl, Orbassano, Turin, 10043, Italy
Keywords: Hydrolysis, BP, Bioplastics, agriculture, surfactants.
Presenting author email: freddy.liendo@hysytech.com

Introduction

Municipal bio-waste, Digested waste, and compost contain a high content of organic compounds with high revalorization potential. A very low-cost and high-efficiency alternative to valorize them is alkaline hydrolysis. The alkaline medium allows the hydrolysis of the organic matter inside the matrix with very promising yields. Furthermore, the conversion of this waste allows the reduction of downstream processing, such as composting (in case of use of digested and waste), and landfill areas. There are several benefits, environmental and economic, through the implementation of this technology due to the different final applications on which can be used Biobased products (BPs). The BPs has a high potential to be employed as Biopolymers, bio-detergents, bio-fertilizers, and bio-stimulants for Anaerobic digestion (AD) enhancement and land reclamation.

Materials and methods

The process was developed in the lab scale by prof. Montoneri and has been optimized in the framework of the LIFECAB project (www.lifecab.eu) and LIFEEBP project (www.lifeebp.eu) towards its industrialization. The so-called BPs has been produced by exploiting the prototypes developed within the LIFECAB and LIFEEBP projects.

Figure 1 shows the mobile prototype developed and constructed within the LIFEEBP project. The product can be obtained both, as a liquid solution useful for AD, land reclamation, agriculture and surfactants, or as a dried solid useful for plastics. The process was constantly controlled and monitored through a Siemens PLC control system. This make it possible to control the different process parameter and assess the process performance and yield.

Figure 1. LIFEEBP prototype installed at ACEA pinerolese premises

Results and discussion

The mobile prototype developed and constructed within the LIFEEBP project. The prototype was operated by using different feedstocks, including digested sludge, and compost from Spain, Italy, Greece, and Cyprus. The process slightly changed in terms of residence times for the digested sludge and compost.

The process was initially optimized in order to reduce the use of caustic soda, and temperature with the LIFECAB prototype. Leading to a process with a pH equal to 13, and temperature equal to 80 °C. The residence time was as well optimized. These process conditions were used for the design of the LIFEEBP prototype. The LIFEEBP prototype was further integrated with a Micro and Ultrafiltration system in order to tune the product properties in terms of Solid content and volatile content. In addition, a drying step was also included in order to reach higher solid content for the different applications.

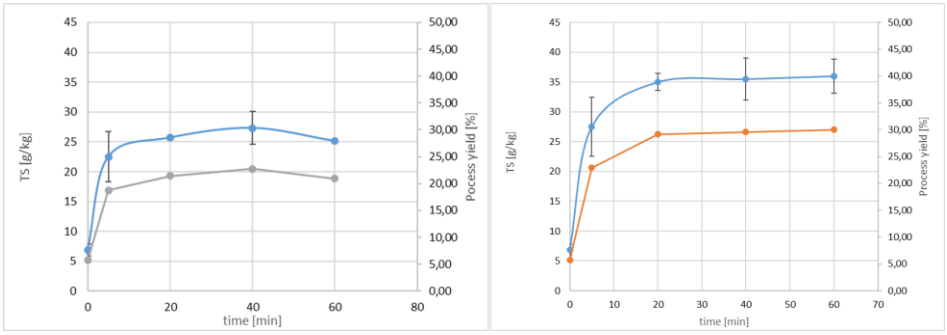

Figure 2. Process parameters optimization. Left) pH 11, Right) pH 13.

Thus, the product can be obtained both, as a liquid solution useful for AD, land reclamation, agriculture and surfactants, or as a dried solid useful for plastics (Fragalà et al., 2023; Padoan, Contillo, et al., 2024; Padoan, Montoneri, et al., 2024). The demonstration of the product performance in such applications is being demonstrated within the LIFEEBP project. Thus, the BPs represent an important alternative for replacing traditional fossil-derived fertilizers, surfactants and plastics. Therefore, the global warming potential of these sectors would significantly be reduced (Montoneri et al., 2022).

The BP production campaigns with the LIFECAB and LIFEEBP prototype have demonstrated that the technology has low CAPEX and OPEX. It entails a production cost of the BPs liquid solution and the solid BP with costs equal to 120 €/ton and 1760 €/ton, respectively (Montoneri et al., 2022). These prices are very competitive compared to other bioproducts such as, Humic acids, PHA, PHB, bio-fertilizers and surfactants already in the market, and even to N-based fertilizers.

Furthermore, it has been demonstrated that BPs are a promising technology to be used for land reclamation, in terms of performance and costs, compared to traditional techniques. Among the traditional techniques, we found Filling materials (sand, gravel, soil, rocks, concrete, construction debris) and Drainage systems (drainage canals, hydraulic pumps, and pipelines to remove excess water). According to the literature, the costs associated with the land reclamation can be reduced from 270 €/m^2 to 15 €/m^2.

Conclusions

Therefore, this emerging technology represents a feasible way to produce BPs with low emissions and costs, with high potential in several markets. The benefits of this technology are many, while the barriers or threats are reduced, which makes it much more interesting for investors and stakeholders. Hysytech is working on the scale up of the technology and bringing it to a continuous operation, which will increase the benefits of the production of these BPs.

References

- Fragalà, F., Puglisi, I., Padoan, E., Montoneri, E., Stevanato, P., Gomez, J. M., Herrero, N., La Bella, E., Salvagno, E., & Baglieri, A. (2023). Effect of municipal biowaste derived biostimulant on nitrogen fate in the plant-soil system during lettuce cultivation. *Scientific Reports*, *13*(1), 1–14. https://doi.org/10.1038/s41598-023-35090-y
- Montoneri, E., Koutinas, M., Padoan, E., Negro, V., Licignano, C., Leone, S., Photiou, P., Kallis, M., Vyrides, I., Liendo, F., Negre, M., Solaro, S., Antonini, M., Mainero, D., Vlysidis, A., Konstantinidis, V., Ladakis, D., Maina, S., & Koutinas, A. (2022). Integrated chemical and biochemical technology to produce biogas with a reduced ammonia content from municipal biowaste. Validating lab-scale research in a real operational environment. *Environmental Science: Advances*, *1*(5), 746–768. https://doi.org/10.1039/d2va00068g
- Padoan, E., Contillo, F., Marafante, M., Montoneri, E., Francavilla, M., Berto, S., & Baglieri, A. (2024). A Low-Cost Ecofriendly Oxidation Process to Manufacture High-Performance Polymeric Biosurfactants Derived from Municipal Biowaste. *Polymers*, *16*(11). https://doi.org/10.3390/polym16111479
- Padoan, E., Montoneri, E., Baglieri, A., Contillo, F., Francavilla, M., & Negre, M. (2024). The Autocatalytic Chemical Reaction of a Soluble Biopolymer Derived from Municipal Biowaste. *Molecules*, *29*(2). https://doi.org/10.3390/molecules29020485

Acknowledgement

This work was carried out within the LIFECAB LIFE16 ENV/IT/000179 project framework and sets the baseline for the LIFEEBP LIFE19 ENV/IT/000004 project, both funded under the LIFE 2016 and 2019 programmes, respectively.