Anaerobic digestion of bioplastics: potential recovery of methane from bio-shopper

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The excessive amount of conventional plastic polymers put on the market and their use in numerous commercial applications represents an issue of global concern (Y. Tokiwa, 2009). To date, bioplastics represent a valid alternative to conventional polymers. These materials have had a rapid spread on the global market since 2019, the year in which the European Parliament voted in favor of a directive to limit the use of single-use plastics (Directive EU 904, 2019).

Once they become waste, biopolymers are usually collected with the organic fraction of municipal solid waste (OFMSW), which represents the fraction present in the highest percentage within separate collection (about 40%). Nowadays, one of the most discussed and researched topics is the management of waste bioplastics and the influence that these can have on the performance of treatment plants for the organic fraction of municipal solid waste (e.g., effects on the chemical-physical characteristics of biogas and/or compost) (S. K. Bhatia, 2021).

The aim of the experimental study is the analysis of the behavior of bio-shoppers in the anaerobic digestion of OFMSW. In particular, anaerobic digestion tests were carried out on several bio-shopper samples in order to evaluate the methane power and the biodegradability rate of these materials.

For the biochemical methane potential tests (BMP), the substrates, supplied by a manufacturer of bio-shoppers for large-scale distribution (certified as compostable according to the UNI EN 13432:2002 standard), were mixed with a culture of anaerobic bacteria, from an anaerobic digestion plant, according to an Inoculum/substrate ratio of 3, referred to the percentage of volatile solids (%VS).

Following characterization of the materials (i.e., substrates and inoculum), degradability tests were carried out under anaerobic conditions (at an average temperature of 35 ± 2 °C) in seven reactors, according to the scheme shown in table 1.

At the end of the BMP tests (which were conducted in triplicate), the biodegradation rate of the substrates was determined, as required by the UNI EN ISO 15985:2018 standard.

Table 1. Summary of samples to be subjected to anaerobic digestion.

Test	Inoculum	Cellulose	Substrate
R1	✓	-	-
R2	✓	-	-
R3	✓	✓	-
R4	✓	✓	-
R5	✓	-	✓
R6	✓	-	✓
R7	✓	-	✓

The results show that R5, R6, R7 has a very short lag phase (about 2 days), attributable to the high degree of crystallinity typical of this material (F. Battista, 2021), followed by rapid and constant gas production, higher than the curves referring to the inoculum alone (R1, R2). With reference to the Biochemical Methane Potential (BMP), the results showed an average value referring to R5, R6, R7 of about 90 ml_{CH4}/g_{VS}, that represents around 65%–70% compared to the contribution of cellulose alone.

Preliminary results allow us to affirm that the bioplastics tested in OFMSW do not have any particular negative effects on the biological stability of the OFMSW digestate.

References

Y. Tokiwa et al. (2009). Biodegradability of Plastics. *International Journal of Molecular of Sciences*.

Directive EU 904/2019. *Direttiva SUP – Single Use Plastic*.

S. Bhatia et al. (2021). Biowaste-to-bioplastic (polyhydroxyalkanoates): Conversion technologies, strategies, challenges, and perspective. *Bioresource Technology*.

F. Battista et al. (2021). Can bioplastics be treated in conventional anaerobic digesters for food waste treatment? *Environmental Technology & Innovation*.