BIOPROCESS DEVELOPMENT FOR THERMOPLASTIC STARCH AND POLYHYDROXYBUTYRATE BIODEGRADATION SYSTEMS USING ALGAL-MICROBIAL CO-CULTURES

F. Pyrilli[1], E. Syranidou[1], M. Koutinas[1, *]

[1]Department of Chemical Engineering, Cyprus University of Technology, Limassol, Cyprus
*(*michail.koutinas@cut.ac.cy)*

ABSTRACT

Bioplastics are considered as the environmental friendly substitute of fossil-based plastics [1], and their production rate is foreseen to increase in the coming years. Manufacturing of plastics using biogenic resources could reduce greenhouse gas emissions by up to 225% compared to conventional plastics [2]. Therefore, defining sustainable end-of-life routes for these materials constitutes a matter of outmost importance. Biological recycling is considered as the most favourable option for a range of popular bioplastics such as thermoplastic starch (TPS) and polyhydroxybutyrate (PHB). The current study presents preliminary findings relevant to the application of microalgal-microbial co-cultures for PHB and TPS biodegradation. Batch experiments were performed in shake flasks under mesophilic conditions employing bioplastic pellets and films as carbon source, while an acclimated microbial community was inoculated. Optimisation methods included *Chlorella vulgaris* co-cultures conducted under 12h:12h light- dark cycles. Physicochemical modifications of the biopolymer along with shifts in the microbial community composition were monitored to understand the underlying mechanisms that controlled the biodegradation process. TPS removal experiments resulted in 14.8% weight reduction following 10 d of incubation using pellets, while films demonstrated higher reduction that reached 30% at 15 d. Evidence is provided demonstrating that the biodegradation of TPS pellets/ films displayed a two-phase pattern with different degradation rates, where biodegradation in the first phase was high and decelerated in the second phase reaching a plateau. Specific bacterial families were dominant in the attached communities depending on biofilm formation and degradation stages. The genera *Microbacterium* and *Achromobacter* played important roles in the biofilm of TPS pellets, while *Bacillus* was dominant in films. The genera *Fusarium* and *Neocosmospora* displayed the highest abundance in all fungal assemblages. Addition of the microalgae in the co-culture slightly increased TPS biodegradation from 18.6 % to 21.4%. Co-cultures conducted using PHB further improved the biodegradation process given that weight reduction increased from 25% to 33.4%. Control biodegradation experiments conducted using only the microalgae exhibited that although 4.7% TPS weight reduction could be achieved by *C.vulgaris*, the microalgae could not biodegrade PHB. This study highlights the potential of the microbial community to be exploited for the development of TPS and PHB waste treatment technologies.

KEYWORDS: Bioplastics, Thermoplastic Starch, Polyhydroxybutyrate, Aerobic biodegradation, Microalgae

REFERENCES

[1] Calabrò, P.S., Grosso, M., 2018. Bioplastics and waste management. Waste Manag. 78, 800–801. https://doi.org/10.1016/j.wasman.2018.06.054

[2] Benavides, P.T., Lee, U., Zare-Mehrjerdi, O., 2020. Life cycle greenhouse gas emissions and

energy use of polylactic acid , bio-derived polyethylene , and fossil-derived polyethylene. J. Clean. Prod. 277, 124010. https://doi.org/10.1016/j.jclepro.2020.124010