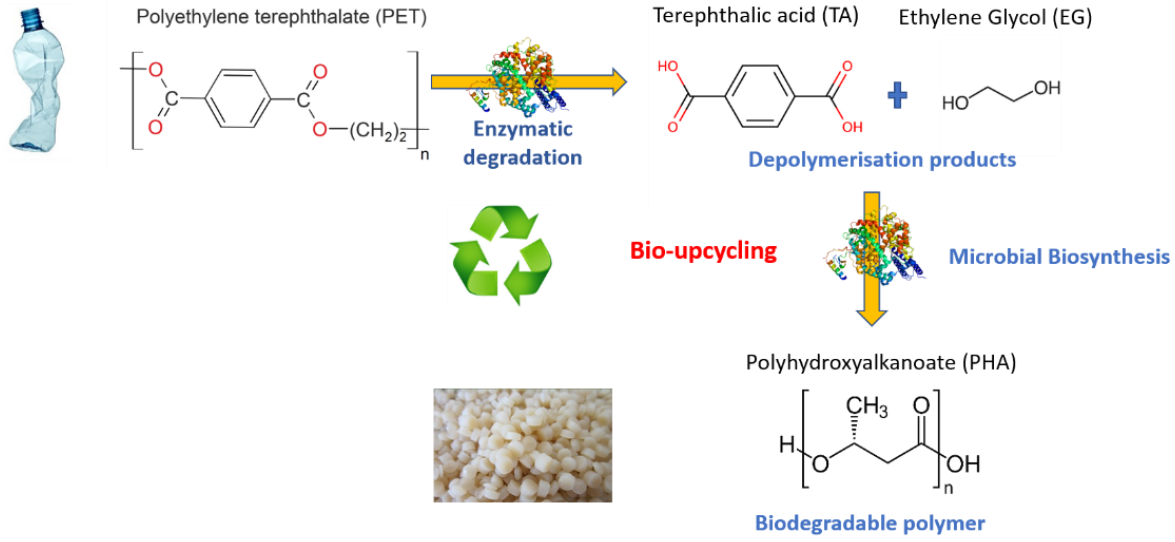
Rozina Kakar

PhD Student SETU

School of Science and Computing (PMBRC)

Plastic consumption has surged over the past half century due to versatility and affordability, with projections indicating that it will double in the next twenty years. Polyethylene terephthalate (PET) is the third most produced polymer worldwide, followed by polyethylene (PE) and polypropylene (PP). The synthesis of PET occurs through transesterification of dimethyl terephthalate and ethylene glycol, or direct polycondensation of terephthalic acid and ethylene glycol. Plastic production has surged from 1.5 million tons in 1950 to 360 million tons in 2018. Meanwhile a growing concern related to the adverse consequences of the current state of the plastic industry. It is evident through scientific and socio-economic studies that marine ecosystems are affected by massive presence of plastics particularly packaging. Millions of tons of plastics in the form of tiny particles or long-lasting forms end up in the oceans which have harmful impacts on marine ecosystem as well as on the economic activities.



(Investigation of the enzymatic degradation of PET followed by bio-upcycling of the TA generated)

My PhD research highlights about microorganisms and enzymes which can break down plastic waste into monomers like terephthalic acid (TA) which can be used to biosynthesize polyhydroxyalkanoate (PHA), a biodegradable polyester. This recycling technology converts PET plastic bottles into PHA, upcycling plastic waste into a useful bioplastic. Microbial enzymes that have potential to degrade PET are majorly lipases and cutinases, the combined action of both enzymes synergistically improves the overall PET hydrolysis process. This study seeks to highlight two potential solutions: biodegradation and upcycling. I will be exploring microbial and enzymatic approaches to measure the biodegradation rate of PET. The screening of microbial isolates will be performed to identify those capable of efficiently degrading PET under various conditions by optimizing pretreatment methods and reaction parameters to increase PET biodegradation rates. In addition, the current study demonstrate how the monomers produced from PET depolymerization can be used as feedstock to biosynthesize new value-added biodegradable polymers like PHA. Moreover, all the methods used according to green chemistry principles. The study also aims to promote a circular economy framework for PET by enhancing a more sustainable and greener world with an innovative green technology.

I am currently in my first year PhD program at South East Technological University working in PMBRC. I had the privilege to present a poster featuring my preliminary work at Environ 2024, in which I have done working on my standard curves for my two analytes of interest which was BHET and TPA and I optimised the HPLC method development. By utilising green analytical metric tools, Methanol was used over Acetonitrile and shortened retention time by varying mobile phases composition and flow rate, which results in less solvent waste.

Commercial enzymes *Candida rugosa*, *Rhizopus niveus*, *Porcine pancreas* and *CALB* were screened for BHET degradation and TPA generation on various temperatures. *Candida rugosa* showed highest degradation at 60°C; *Rhizopus niveus* most effective at 50°C; both peaked in MHET generation at 60°C, suggesting temperature-specific activity. For TPA, *CALB* most efficient (21% yield) at 37°C, dropping significantly at higher temperatures, indicating its optimal activity for TPA is at moderate temperatures. In contrast, *CALB* maintained the ability to generate MHET across the temperature range evaluated.

The Environ was hosted by South East Technological University where I volunteered to serve as a member of the organizing committee as well, I have gained invaluable insights throughout the conference.