

Characterization and Biological Insights into PET Micro- and Nanoplastics Prepared via Hydrolysis and Glycolysis

Mohammed Monsoor Shaik¹, Calogero Gagliano¹, Diletta Ami¹, Antonino Natallelo¹, Alessio Romerio¹, Alice Italia¹, Federico Lami¹, Grisha Pirianov², Francesco Peri¹

E-mail: mohammed.shaik@unimin.it

¹ University of Milano-Bicocca, Italy

² Anglia Ruskin University, United Kingdom

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Abstract:

Micro and nanoplastics (MNPs) have become ubiquitous environmental pollutants, raising concerns about their potential impact on human health. Polyethylene terephthalate (PET), widely used in food packaging, is particularly significant due to its prevalence and durability. The breakdown of PET's ester bonds leads to the formation of various oligomeric fragments, including those terminated with hydroxyl, carboxyl, or both functional groups. These fragments contribute to the diverse array of PET MNPs found in the environment.

Addressing the critical gap in standardized PET MNPs for research, we prepared two different PET MNPs via acid hydrolysis and glycolysis methods. Characterization by dynamic light scattering and nanoparticle tracking analysis revealed a uniform particle size distribution of around 350 nm. All the MNPs were negatively charged (~ -22 mV), suggesting they are stable in suspension. FTIR spectra confirmed that the MNPs are composed of hydroxyl- and carboxyl-ending oligomers, revealing distinct differences in the surface chemistry of the generated oligomeric fragments. Preliminary studies on the biological activity of PET MNPs revealed distinct cellular responses based on their surface chemistry. Hydroxyl-terminated PET MNPs induced inflammation and were associated with pyroptosis through IL-1 β release, while carboxyl-terminated PET MNPs triggered apoptotic pathways.

This comprehensive approach aims to enhance understanding of PET MNPs' environmental and health impacts, fostering interdisciplinary collaborations to address this pressing issue.