

Plastic Nanoparticle (PNP)- Oxaliplatin Cotransport in Saturated Soil

**PHILLIP VERSHININ, ISHAI DROR AND BRIAN
BERKOWITZ**

Weizmann Institute of Science

Plastic pollution has emerged as a critical global environmental issue, with macroplastics fragmenting into microplastics and, ultimately, into plastic nanoparticles (PNPs) after being subjected to different weathering processes. These PNPs (also classified as secondary PNPs) are the most prevalent environmental plastic particles yet significantly understudied. These nanoparticles, due to their high surface-area-to-volume ratio and physicochemical properties, may enhance or inhibit the mobility of pollutants in soil and groundwater. The objectives of this study were to investigate the influence of PNPs on the transport dynamics of oxaliplatin, a widely used chemotherapeutic agent, under environmentally relevant conditions. Five common plastic types—PET, PP, PS, LDPE, HDPE, along with landfill-extracted PNPs that have undergone more than five decades of environmental weathering—were examined utilizing a fully saturated soil system. The interactions between PNPs and oxaliplatin were examined, providing new insights into the complex interplay between plastic-derived nanoparticles and pharmaceutical contaminants in subsurface environments. Distinct transport and retention patterns emerged across PNP types, with oxaliplatin retention in soil ranging from 38% to 53%. Particle size was a key factor, as smaller PNPs exhibited a higher tendency to aggregate, enhancing retention. For instance, secondary PS facilitated greater oxaliplatin retention than primary PS beads. The surface charge further influenced interactions, with plastics exhibiting lower zeta potential (weaker surface charge) demonstrating stronger sorptive behavior—evident in HDPE versus LDPE. Additionally, plastic density was a critical determinant, as denser materials such as PET exhibited lower mobility than less dense plastics like PP. Remarkably, landfill-extracted PNPs displayed a biphasic transport pattern characterized by an initial breakthrough and a secondary release, indicating the presence of heterogeneous plastic fractions with differing transport dynamics. These findings offer new insights into the role of PNPs in contaminant transport and emphasize the need to consider particle-specific properties when assessing their environmental impact. The results highlight a colloid-facilitated transport mechanism, where PNP properties govern both their mobility and their influence on contaminant transport. This study underscores the complexity of PNP-contaminant interactions and emphasizes the need for further research into their environmental implications.