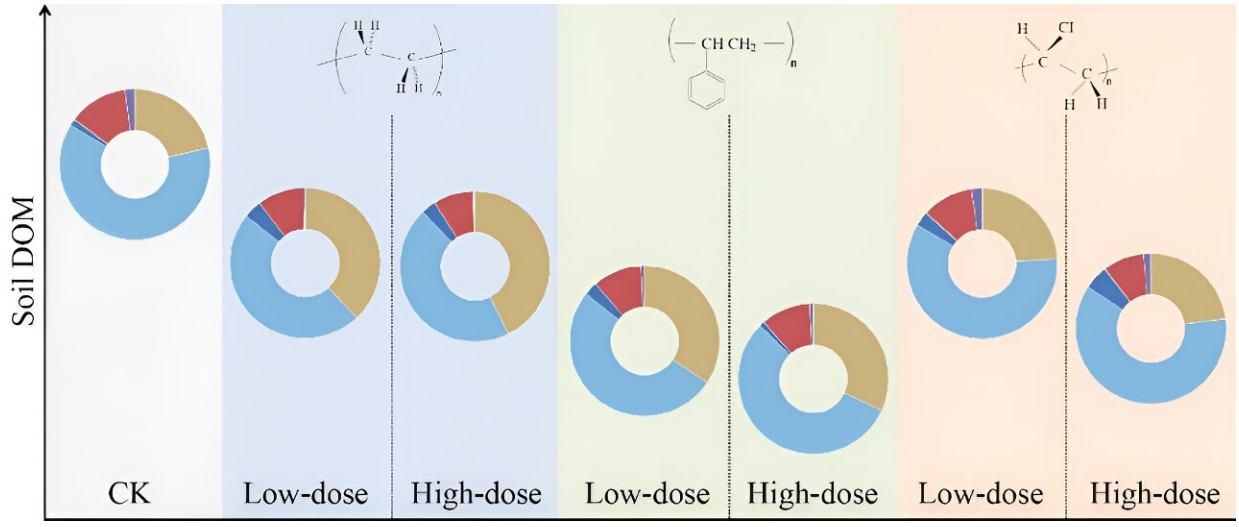
Study finds chemodiversity of soil-dissolved organic matter altered by microplastics

January 19 2024



Credit: *Frontiers of Environmental Science & Engineering* (2023). DOI: 10.1007/s11783-023-1753-6

Soil is the largest reservoir of microplastic (MP), with the corresponding content being 4 to 23 times that in oceans. Plastics are widely used in production and daily life due to their low cost, good ductility and durability. However, approximately 80% of plastics ultimately accumulate in soil, rivers, and marine environments.

These plastic wastes are decomposed into smaller fragments and gradually form microplastic fragments or particles with a size of soil

systems in various ways.

The effects of microplastics on soil ecosystem function are of great significance. MPs may alter soil porosity, aeration, pH, organic matter, nutrient content, as well as transport, bioavailability, and toxicity of environmental pollutants. Furthermore, MPs directly interact with soil microorganisms to form the soil plastisphere and affect the diversity and metabolic activities of soil microbes by changing soil physicochemical properties. Ultimately, MPs may threaten soil ecosystem functioning.

Dissolved organic matter (DOM), as an important component of soil organic matter (SOM), directly involved in a series of biogeochemical processes such as soil nutrient cycling, greenhouse gas emissions, and pollutant migration. Soil DOM is influenced by changes in microbial processes, environmental factors, and soil properties, such as soil pH and C/N ratios. MPs may alter soil pH and C/N ratios, affect microbial diversity and metabolic processes, and in turn affect DOM quantity and composition in soil.

DOM helps to dictate the processes that control SOM accumulation and stabilization. However, only limited attention has been paid to the effects of MPs on soil DOM, and a few studies have analyzed the effects of MPs on SOM composition and chemical structure.

Consequently, considering that the effects of MPs on DOM chemodiversity are not sufficiently understood, particularly under different types of polymers, the researcher team from Chinese Research Academy of Environmental Sciences selected three common MPs (polyethylene (PE), polystyrene (PS), and polyvinyl chloride (PVC) to study their effects on the chemical properties and composition of soil DOM.

Their work will contribute to a more comprehensive understanding of

the long-term impact of plastic pollution on the ecosystems. The study, entitled "Chemodiversity of soil dissolved organic matter affected by contrasting microplastics from different types of polymers," is published in *Frontiers of Environmental Science & Engineering*.

The team selected three prevalent MPs (PE, PS, and PVC) for 310-d soil incubation experiments. The influences of different concentrations and types of MPs on the chemodiversity of soil DOM, including the chemical properties, fluorescent characteristics and molecular composition of DOM, were analyzed using ultraviolet (UV)–visible spectroscopy, three-dimensional (3D) fluorescence spectroscopy and Fourier-transform ion cyclotron resonance mass spectrometry (FT-ICR MS). Furthermore, the team assessed the main driving factors of DOM molecular chemodiversity induced by MPs.

Their results showed that MPs reduced the aromatic and hydrophobic soil DOM components by more than 20%, with PVC MPs having the greatest effect. Furthermore, as MP contents increase, the humification level of soil DOM significantly decreases. MPs increased DOM molecules with no heteroatom by 8.3%–14.0%, but decreased DOM molecules with nitrogen content by 17.0%–47.8%.

This may be because MPs cause positive "priming effect," resulting in the breakdown of bioavailable components in soil DOM. This is also related to MPs changing microbial richness and diversity and enriching microbial communities involved in lignin compositions degradation. In the presence of MPs, soil DOM chemodiversity depended on soil pH, electrical conductivity, dissolved organic carbon, soil organic matter, bacterial Shannon, and fungal Chao index.

Their work presented that DOM in MP-contaminated soils featured more lipids and less condensed aromatics and proteins/amino sugars, thereby conferring a lower DOM aromaticity and higher lability. This

study warned of the threat to soil ecosystem function, and future studies may focus on evaluating the dynamic effects of different sizes of MPs on soil carbon sink formation processes. This will contribute to a more comprehensive understanding of the long-term impact of plastic pollution on the ecosystems.

More information: Hong Yu et al, Chemodiversity of soil dissolved organic matter affected by contrasting microplastics from different types of polymers, *Frontiers of Environmental Science & Engineering* (2023). DOI: 10.1007/s11783-023-1753-6

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