NJ Department of Environmental Protection
Division of Science and Research

A Factsheet: PFAS Occurrence, Biotransformation, and Transport through Vegetation

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What was the purpose of the study?

This study had two main goals focused on a family of chemicals called per- and polyfluoroalkyl substances (PFAS). First, the researchers wanted to create a sensitive method to analyze both specific (i.e., known) and unknown PFAS using a tool called high-resolution mass spectrometry (HRMS). They used this method to study how two specific PFAS (6:2 FTCA and 5:3 FTCA) underwent biotransformation (i.e., modification of a chemical structure by biological processes). The specific analysis helped measure these two PFAS, whereas the analysis of unknowns looked at new substances that were formed. The second goal was to measure PFAS levels in plants and soil from different places in New Jersey and to figure out what factors affect how PFAS move into and through these plants.

What was the general approach to the study?

In the first part of the study, researchers used a technique called nano-electrospray ionization (Nano-ESI) along with a tool called high-resolution mass spectrometry (HRMS) to study both specific and unknown PFAS chemicals (see Fig. 1). Nano-ESI produced a signal intensity that was two to three times stronger than what would be achieved with the conventional method, even with a small sample volume. The authors compared how sensitive and accurate this new method was to another method called Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS). Then, they used the new method to see how the two specific PFAS chemicals, 6:2 FTCA and 5:3 FTCA, changed when exposed to a bacteria found in plant roots.

In the second part of the study, researchers collected plant tissues, surface water, and soil samples from six sites in New Jersey. They tested these samples for PFAS using the LC/MS/MS method. The PFAS was measured in all media, and these results were used to understand how PFAS moves through vegetation.

Overall, what did the studies show?

Using Nano-ESI to develop an analytical method could make it easier to accurately measure many different types of PFAS compared to the LC/MS/MS technique. This approach can help find and identify new PFAS characteristics in various materials. Additionally, the researchers created a two-level system to better measure exact amounts of known PFAS and estimate amounts of unknown PFAS. When this method was used to detect free (gaseous) fluorine released during the change process, the researchers measured how fast and how much fluoride was released using different carbon sources. The results showed that the breakdown of 6:2 FTCA by the bacteria in plant roots depended on the type of soil present.

The study looked at how much PFAS was present in different environmental media (i.e., soil and water) to determine how these chemicals move between the soil and water. They also tracked how PFAS moved through plants, from the roots to the stems and leaves. The study considered different factors that might affect how PFAS moves through the plants, such as pH levels, mineral content, organic carbon content, and the chemical's molecular weight. They found that the molecular weight had the biggest impact on how much PFAS was in the soil and available to plants, while the amount of organic carbon in the soil did not have much of an effect.

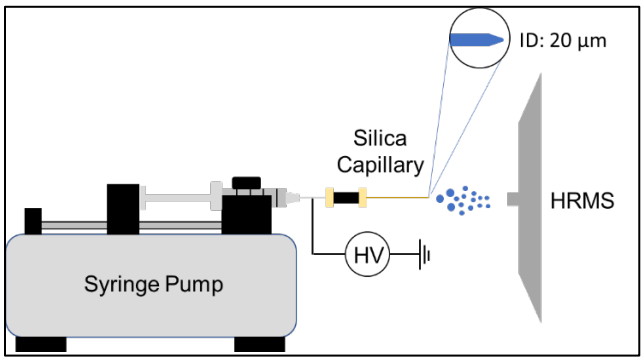

Figure 1 Schematic of Nano-ESI-HRMS (with nanodroplets). PFAS analysis by Nano-ESI-HRMS was operated by a high-resolution Q Exactive hybrid quadrupole–Orbitrap mass spectrometer (Thermo Fisher Scientific, San Jose, CA) equipped with a Nano-ESI injector.

How will DEP use the data?

The New Jersey Department of Environmental Protection (NJDEP) knows that improvements to the methods used to detect and measure PFAS in our environment are crucial to managing the release of PFAS into the environment and subsequent treatment. The new method developed in this study is an important step toward creating a more dependable way to find PFAS that are not usually detected by standard commercial methods. Using this new approach to study how certain PFAS chemicals change over time helps us learn more about the conditions needed for these transformations to happen.

The results from studying the soil, surface water, and plant materials collected in New Jersey help us to better understand potential PFAS contamination. By looking at how PFAS spread between the soil and water and move through plant tissues, researchers are learning more about how these chemicals travel through our environment.

References:

For a full list of references used in this study, please refer to the list available within the posted report.

Please review the full report for more detailed information at https://hdl.handle.net/10929/141968

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Who to contact with further questions.

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