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High-resolution Mass Spectrometry in the Identification of Persistent Organic Pollutants in Aquatic Systems

Serap Meeron*

Department of Biochemistry, Ege University, Izmir, Turkey

Introduction

The ongoing environmental challenges posed by Persistent Organic Pollutants (POPs) in aquatic systems have gained considerable attention due to their long-lasting impacts on both the environment and human health. POPs, which include a wide variety of chemical substances, are characterized by their persistence in the environment, ability to bioaccumulate in living organisms, and potential to cause harm to ecosystems and human health. These pollutants can enter aquatic environments through various pathways, including industrial discharges, agricultural runoff, wastewater effluents, and atmospheric deposition. Once in water bodies, POPs can travel long distances, often reaching remote areas, making their monitoring and identification crucial for environmental protection and public health. As the impact of POPs becomes more widely recognized, there is an increasing demand for advanced analytical techniques to monitor their presence and quantify their concentrations in aquatic systems. One such powerful tool that has revolutionized the detection and characterization of POPs is High-Resolution Mass Spectrometry (HRMS).

Description

One of the primary advantages of HRMS in identifying POPs is its ability to detect a wide range of contaminants with minimal sample preparation and without the need for prior chemical derivatization. HRMS can identify known POPs, such as Polychlorinated Biphenyls (PCBs), organochlorine pesticides (e.g., DDT and lindane), and Polycyclic Aromatic Hydrocarbons (PAHs), by comparing the measured m/z values with databases of known compounds. The high mass accuracy of HRMS allows for the identification of these compounds even at trace levels, which is particularly important for monitoring environmental pollutants that may be present at concentrations below regulatory limits. Furthermore, HRMS enables the detection of emerging or previously unreported POPs, such as newer flame retardants or pharmaceuticals, that may have been overlooked by traditional analytical methods. This ability to discover new pollutants is especially critical in the face of rapidly changing chemical usage patterns and the emergence of novel contaminants in aquatic environments. In addition to its ability to identify known and unknown POPs, HRMS offers several other advantages for environmental monitoring.

One key benefit is its sensitivity, allowing for the detection of trace concentrations of pollutants in aquatic systems. POPs, by their very nature, are persistent and can accumulate in the environment, often at low levels over time. HRMS allows for the accurate measurement of these low concentrations, providing valuable data for environmental agencies tasked with monitoring water quality and assessing pollutant levels. Additionally, HRMS enables the quantification of POPs in complex matrices, such as environmental samples, where the presence of interfering substances may complicate the analysis. The high resolution of HRMS allows for the separation of overlapping peaks, making it possible to accurately measure the concentration of individual contaminants even in the presence of complex background signals [1,2].

Conclusion

In conclusion, high-resolution mass spectrometry has emerged as a powerful tool for the identification and quantification of persistent organic pollutants in aquatic systems. Its high sensitivity, specificity, and ability to detect both known and unknown contaminants make it an invaluable technique for monitoring environmental pollution. As research continues to expand, HRMS will play an increasingly critical role in identifying emerging pollutants, understanding their environmental distribution, and assessing their potential risks to ecosystems and human health. While challenges remain in terms of sample complexity, database limitations, and the need for advanced sample preparation techniques, the continued development of HRMS and its integration with other analytical tools will likely lead to more effective and efficient monitoring of POPs in aquatic environments.

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***Address for Correspondence:** Serap Meeron, Department of Biochemistry, Ege University, Izmir, Turkey, E-mail: meeron.serap@eft.edu.tr*

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