K51 Capsule Phase Microextraction (CPME): A Powerful New Arsenal in Analytical and Forensic Sample Preparation

Abuzar Kabir, PhD, Florida International University, 11200 SW 8th Street, AHC4-215, Miami, FL 33199*

After attending this presentation, attendees will have a thorough understanding of the fabrication, working principle, and advantages of CPME in preparing different analytical, environmental, toxicological, pharmaceutical, food, and forensic samples for chromatographic separation and identification.

This presentation will impact the forensic science community and scientists interested in analyzing trace organic analytes in various sample matrices by potentially offering a paradigm-shift approach in sample preparation by the total elimination of sample pre-treatment steps such as filtration, protein precipitation, centrifugation, etc. from the sample preparation workflow, which is notoriously time consuming, error prone, and labor intensive.

Due to the ever-increasing demands from the public and regulators wishing to establish the principle of Green Analytical Chemistry (GAC) in all aspects of the analytical process, the current trend in sample preparation inevitably favors miniaturization of the extraction device, reduced sample volume, reduced organic solvent consumption, and a minimized amount of waste generated in the sample preparation process. Owing to the high consumption of toxic and hazardous organic solvent and other shortcomings of major sample preparation techniques, including Liquid-Liquid Extraction (LLE) and Solid Phase Extraction (SPE), a number of miniaturized and green sample preparation techniques, such as Solid-Phase Microextraction (SPME), Stir Bar Sorptive Extraction (SBSE), Thin Film Microextraction (TFME), Microextraction by Packed Sorbent (MEPS), and Fabric Phase Sorptive Extraction (FPSE), have emerged during the past few decades.[1-5] These techniques are desirable as environment friendly, require smaller sample volume, and are faster, more sensitive, and efficient.

Although the new generation of sample preparation techniques represents improvements, most of these techniques cannot directly handle real-life analytical, environmental, toxicological, pharmaceutical, food, and forensic samples, which often contain high volumes of particulates, debris, biomasses, and other matrix interferents. Sample pretreatment steps, such as filtration, centrifugation, protein precipitation, etc., are often needed, leading to significant analyte loss with serious ramifications on forensic evidence.

CPME has been developed to focus on the majority of the shortcomings not adequately addressed by other sample preparation techniques.[6] CPME completely eliminates the sample pretreatment/clean-up step from the sample preparation workflow. CPME utilizes a porous tubular polypropylene membrane capsule with a 0.2µm pore size and 1.8mm internal diameter to encapsulate sol-gel hybrid organic-inorganic sorbent in the form of monolithic bed or spherical particles. The porous membrane capsule allows easy permeation of aqueous sample containing the target analyte(s) while protecting the sorbent from being contaminated by matrix interferents. A magnetic metal rod embedded in the microextraction capsule allows for spinning the device when placed on a magnetic stirrer and diffuses the sample matrix for fast analyte-sorbent interaction and rapid extraction equilibrium. High loading of sol-gel sorbent provides excessive sample capacity for target analyte(s) and fast extraction kinetic due to the sponge-like porous architecture of the sol-gel sorbent. Protection of the sorbent from contamination via encapsulation into a porous tubular membrane capsule has made CPME an impressive and robust sample preparation technique. After the extraction, a small volume of organic solvent can be used to desorb the accumulated analyte(s). Due to the high pre-concentration factor achieved in CPME, no solvent evaporation and sample reconstitution is required. The prepared

sample can be analyzed by gas chromatography, liquid chromatography, or capillary electro chromatography to obtain complimentary information if a mutual solvent equally compatible with these chromatographic techniques is chosen.

Analytical data obtained from a number of real-life applications of CPME, including illicit drug residues and their metabolites in urine and blood samples, will be presented to showcase its advantages, extraction characteristics, performance superiority, and analytical figures of merit.

Reference(s):

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Capsule Phase Microextraction, Sample Preparation, Green Analytical Chemistry