Using espresso machines to do chemistry

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Credit: American Chemical Society

Many chemists are familiar with taking trips to the espresso machine while running late-night experiments, but until now these excursions

were merely undertaken for the caffeine boost. A group recently reported in ACS' *Analytical Chemistry*, however, that espresso machines can quickly and inexpensively perform some complex chemistry experiments, such as testing for harmful compounds in the environment.

Polycyclic aromatic hydrocarbons (PAHs) are a class of carcinogenic organic compounds that are ubiquitous in the environment. They are generated by incomplete combustion of materials in forest fires, industrial plants and waste incinerators. To determine the levels of PAHs in soil and sediment, researchers first extract the compounds from a sample, a step that can take up to 16 hours and requires large amounts of hazardous solvents. Newer techniques that use high temperatures are faster and need much less solvent, but they require pricey lab equipment. So Francesc A. Esteve-Turrillas and colleagues set out to determine whether an espresso machine—which quickly runs hot liquid through a small amount of coffee, or in this case, soil—could efficiently extract PAHs for further analysis.

The group percolated a soil sample in an espresso machine with a small amount of organic solvent and water. The extracted sample was then analyzed with a standard chromatography procedure to determine the amount of PAHs present. All told, the process takes only 11 seconds. The results from the espresso procedure were comparable to those obtained with certified techniques, but the new process was significantly less expensive and faster. The researchers say that this study shows that espresso makers can be used as low-cost alternatives in chemistry labs. They are currently testing to see whether these machines can extract and analyze pesticides, pharmaceuticals and detergents in food and environmental samples.

More information: Sergio Armenta et al. Hard Cap Espresso Machines in Analytical Chemistry: What Else?, *Analytical Chemistry* (2016). DOI: 10.1021/acs.analchem.6b01400

Abstract

A hard cap espresso machine has been used in combination with liquid chromatography with molecular fluorescence detection for the determination of polycyclic aromatic hydrocarbons (PAHs) from contaminated soils and sediments providing appropriate extraction efficiencies and quantitative results. Naphthalene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benz[a]anthracene, chrysene, benz[b]fluoranthene, benz[k]fluoranthene, benz[a]pyrene, dibenz[a,h]anthracene, benz[ghi]perylene, and indeno[1,2,3-cd]pyrene were used as target compounds. It should be mentioned that the pairs benz[a]anthracene–chrysene and dibenz[a,h]anthracene–benz[ghi]perylene peaks coelute under the employed chromatographic conditions; thus, those compounds were determined together. PAHs were extracted from 5.0 g of soil, previously homogenized, freeze-dried, and sieved to 250 μm, with 50 mL of 40% (v/v) acetonitrile in water at a temperature of 72 ± 3 °C. The proposed procedure is really fast, with an extraction time of 11 s, and it reduces the required amount of organic solvent to do the sample preparation. The obtained limit of detection for the evaluated PAHs was from 1 to 38 μg kg–1. Recoveries were calculated using clean soils spiked with 100, 500, 1000, and 2000 μg kg–1 PAHs with values ranging from 81 to 121% and good precision with relative standard deviation values lower than 30%. The method was validated using soil and sediment certified reference materials and also using real samples by comparison with ultrasound-assisted extraction, as reference methodology, obtaining statistically comparable results. Thus, the use of hard cap espresso machines in the analytical laboratories offers tremendous possibilities as low cost extraction units for the extraction of solid samples.

Provided by American Chemical Society

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