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Advanced GC-MS-SIM method for simultaneous determination of isphenol-A and phthalic acid esters (PAEs) in seawater

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ABSTRACT

In response to environmental concerns and the need for precise analytical methods, a highly sophisticated gas chromatography-mass spectrometric (GC-MS) technique was developed for the simultaneous quantification of bisphenol-A (BPA) and three common phthalic acid esters (PAEs) in seawater samples. This novel method was meticulously designed to ascertain the total concentration of PAEs present in collected seawater samples, thus addressing environmental and health-related concerns in Qatar which is the main source of domestic water supply. The development of the extraction method for the determination of BPA, dibutyl phthalate (DBP), benzyl butyl phthalate (BBP), and bis(2-ethylhexyl) phthalate (DEHP) involved a comprehensive optimization process. Four crucial parameters, including the selection of the solvent, manipulation of physical conditions, and precise determination of the volume of acid, were meticulously refined. The extraction process was achieved through liquid-liquid extraction employing dichloromethane as the solvent. A 50 mL of seawater was previously adjusted to pH 4.0 with 50 µL of HCl (36-37%), then the mixture was manually shaken for 1 min with 2 mL of DCM. To further enhance precision, an ultrasonic water bath shaker was utilized for a precisely timed 30 min extraction period, all conducted at room temperature. Analytes, namely DBP, BPA, BBP, and DEHP, exhibited distinct and well-defined retention times of 10.2, 11.2, 11.9, and 12.7 min, respectively, within the chromatographic system. Our method demonstrates remarkable sensitivity, with instrument detection limits established at 0.09, 0.43, 0.33, and 0.93 µg/L for DBP, BPA, BBP, and DEHP, respectively. Furthermore, the calibration curve working ranges were thoughtfully determined to span from 2.5 µg/L to 250 µg/L for each of the target compounds. In assessing the precision of our method, relative standard deviation (RSD), indicating precision, consistently fell within the range of 0.87% to 11.10% for DBP, BPA, BBP, and DEHP. Additionally, recovery values spanning from 80.9% to 103.7% demonstrated the robustness and accuracy of our method across a range of sample matrices. In our comprehensive analysis of seawater samples, it was evident that the concentration levels of DBP, BPA, BBP, and DEHP remained well below the stringent standards established by the Environmental Protection Agency (EPA) for DEHP (6 µg/L) and the United States Environmental Protection Agency (USEPA) for PAEs (3.0 µg/L) in raw water. These results underscore the effectiveness and reliability of our advanced GC-MS method, which holds significant promise for environmental monitoring and health-related research.

Keywords: BPA; PAEs; Seawater; GC-MS-SIM

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