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Emerging Contaminants in Waste Management: Plasticizer Release from Sri Lankan Landfill Sites

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Abstract

Plastic waste in open dumpsites has emerged as a significant environmental issue due to its persistence and widespread distribution. Over time, they break down into smaller particles like microplastics and nano-plastics, which can leach out plasticizers into landfill leachate. The quantification of plasticizers in leachate has gained increasing importance, as they migrate into soil, surface water systems, and groundwater, posing potential environmental and health risks such as reproductive difficulties and developmental defects. This study aims to quantify the abundance of three commonly used plasticizers, Bisphenol A (BPA), Benzophenone (BP), and Di (2- ethylhexyl) phthalate (DEHP) in landfill leachates, adjacent waters, and leachate-impacted sediments in municipal solid waste dumpsites in the Western Province of Sri Lanka. A spatially representative sampling design was employed, covering leachate discharge points, downstream surface waters, and leachate-impacted sediments at each dumpsite by collecting eleven leachate samples, eleven sediment samples, and five adjacent water samples from five major dumpsites. Solid phase extraction (SPE) procedure was used to isolate plasticizers from aqueous samples, while sediment samples were subjected to solvent extraction using dichloromethane. Resulting extracts were analyzed using High Performance Liquid Chromatography (HPLC) equipped with a UV detector. The analysis revealed the presence of DEHP, BPA, and BP in all matrices. In landfill leachates, average concentrations were recorded between 0.379-2.236 mg L^{-1} for BPA, 0.056-0.335 mg L^{-1} for BP, and 0.059-0.383 mg L^{-1} for DEHP. Adjacent surface waters exhibited comparatively lower levels, ranging from N/D-0.012 mg L^{-1} for BPA, N/D-0.030 mg L^{-1} for BP, and N/D-0.365 mg L^{-1} for DEHP, indicating dilution and dispersion effects. Sediment samples, however, depicted higher accumulation, with average concentrations varying from N/D-2.609 mg kg^{-1} for BPA, N/D-0.227 mg kg^{-1} for BP, and N/D-2.991 mg kg^{-1} for DEHP, reflecting the hydrophobic nature of plasticizers and their strong sorption to organic-rich solid phases. Statistically, Karadiyana, Kochchikade, and Kelaniya dumpsites recorded the highest contamination levels across all three matrices. The accumulation of plasticizers in sediments highlights their role as long-term contaminant sinks, with potential for remobilization under changing geochemical conditions, posing sustained ecological risks. These findings highlight the widespread contamination of aquatic and sedimentary environments by landfill-derived plasticizers in Sri Lanka, which can be attributed to the lack of engineered leachate collection and treatment systems. Overall, the findings provide critical baseline data to support environmental risk assessment and the development of sustainable leachate management and treatment strategies to mitigate plasticizer contamination in surrounding ecosystems.

Keywords: *Municipal solid waste, Bisphenol A, Benzophenone, Phthalate, Landfill leachate*

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