Determination of Polycyclic Aromatic Hydrocarbons in the Water, Soils and Surface Sediments of the Msunduzi River, kwazulu-Natal, South Africa

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Abstract:

Polycyclic aromatic hydrocarbons (PAHs) are organic pollutants which are known carcinogens. Their presence in the environment has been linked to cancer, neurological and reproductive illnesses to name but a few. Hence it is important to monitor the levels of these PAHs in order to identify areas of high pollution and possible toxic exposure to aquatic and human life. Water samples were extracted using a liquid-liquid extraction technique into dichloromethane and dehydrated with sodium sulphate anhydrous. The soils and surface sediments were extracted with a mixture of dichloromethane and n-hexane (1:1 v/v) using the soxhlet extraction technique. The crude extracts were purified by silica gel packed column chromatography. The concentrations of PAHs in the extracts were analysed by GC-MS. The instrument was calibrated using internal standardization (deuterated PAH) and PAH standards. Percentage recoveries of 7 PAHs in the spiked and equilibrated samples varied from 79.16±0.01 to 101.28±0.02 and 80.30±0.02 to 105.56±0.01 for solid and water samples, respectively. The grand average in the summed concentrations of concentrations of the 7 PAHs in the water for all seasons decreased in the order: Σ[7-PAH] spring > Σ[7-PAH] summer > Σ[7-PAH] autumn > Σ[7-PAH] winter while in the surface sediments was in the order: Σ[7-PAH] spring > Σ[7-PAH] autumn > Σ[7-PAH] summer

> Σ[7-PAH] winter and in the soils was in the order: Σ[7-PAH] spring > Σ[7-PAH] autumn > Σ[7-PAH] winter

> Σ[7-PAH] summer. The concentration of PAHs was found to be comparatively higher in the soils and surface sediments than in the water samples.

Ultrasonic extraction (UE), Soxhlet extraction (SE) and strong stage extraction (SPE) have been created and connected for the synchronous assurance of the five most commonly utilized triazine pesticides. The extraction parameters that influence the recuperation of the analytes for SPE, SE and UE strategies were optimized some time recently the application of the strategies. The SPE optimized parameters were conditioning dissolvable and test volume. The UE optimized parameters were: extraction dissolvable, the volume of extraction dissolvable and extraction time. The SE optimized parameters were extraction dissolvable and test wetting. The examinations were conducted employing a high-performance fluid chromatography-diode cluster locator (HPLC-DAD) which was moreover optimized to progress the constrain of measurement and locate on.

Exposure and pathways of PAHs:

PAHs are show in climatic, sea-going and earthbound environments at concentration levels that depend on the area, nature of the anthropogenic sources of emission and the winning climate circumstances. As a result of this, presentation of people to PAHs is anticipated to be higher within the climate of an urban-built environment, including its water accepting civilities.

Solid-phase extraction (SPE) and ultrasonic extraction (UE) procedures taken after by Gas Chromatography-Mass Spectrometry (GC-MS) have been adjusted for subjective and quantitative examination of polycyclic fragrant hydrocarbons (PAHs) in water and dregs tests. Rate recuperations of PAHs extended from 85 to 121% in water and 82 to 117% in dregs tests. The limits of location (LOD) and limits of measurement (LOQ) extended from 0.02 to 0.2 and 0.05 to 0.5 µg/L for SPE whereas for UE, they were between 0.008–0.09 and 0.02–0.30 µg/kg, separately. The concentration levels of PAHs (naphthalene, acenaphthene, acenaphthylene, fluorine, anthracene, phenanthrene and pyrene) identified in water tests were 0.071–2.7, 2.0–10.4 and 2.5–3.5 µg/L in wastewater, stream water, and dam water, separately. In dregs tests, concentration levels of PAHs were between 2.8–42.0 and 2.8–3.9 µg/kg, in waterway and dam silt, separately.

Strategy OF ANALYSIS

The 16 PAHs, naphthalene (Rest), acenaphthylene (Acy), acenaphthene (Can), fluorene (Flu), phenanthrene (Phe), anthracene (Subterranean insect), fluoranthene (Flt), pyrene (Pyr), benzo[a]anthracene (BaA), chrysene (Chy), benzo[b]fluoranthene (BbF), benzo[k]fluoranthene (BkF), benzo[a]pyrene (BaP), dibenzo[ah]anthracene (DBA), benzo[ghi]perylene (BgP) and indeno[123-cd]pyrene (IcP), benchmarks were acquired from Supelco, Bellefonte, Dad, USA. Dichloromethane (DCM), n-hexane, other solvents and chemicals were gotten from Sigma-Aldrich (South Africa)

Extraction and SPE clean-up of PAHs:

A strong stage extraction (SPE) strategy was created for the recuperation of the 16 PAHs. The clean-up of PAHs was carried out with C18 strong stage extraction tubes (Supelclean ENVI -18 SPE tubes 6mL), obtained from Supelco, Bellefonte, USA. The extraction of PAHs was carried out with n-hexane in 5 extraction arrangements (25, 20, 15, 10 and 10 mL) and used 250 mL of Milli-Q water as lattice for the recuperation method. Clean-up was done on SPE tubes that have been pre-conditioned with n-hexane and DCM (3 mL each of DCM, n-hexane and DCM/hexane (1:1) sequentially).

The extraction was carried out by measuring a 250-mL water test into a pre-cleaned 500-mL isolating pipe, taken after by the expansion of the specified volume of the extricating dissolvable. The substance of the pipe was altogether blended for 1 min and permitted to stand for 2 h to permit

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for stage partition between the natural stage and the polar stage.

Results and Discussion:

GC-FID strategy advancement and validation Chromatographic separation The chromatogram of the examined 16 need PAHs gotten from the GC-FID is displayed. The division of the different component PAHs is unmistakable (sharp crests), inside worthy determination and satisfactory affectability for the discovery and quantitation of the PAH analytes. Recovery of PAHs:

The productivity of the SPE method for the concentration of the PAH analytes was induced from normal rate recuperation gotten from triplicate examination of PAHs extricated from spiked frameworks. The recuperation of the 16 PAHs from the watery frameworks is included within the Appendix. The most reduced normal rate recuperation was $60.05 \pm 9.45\%$ for Rest, whereas normal rate recuperation for all other PAH analytes extended between $83.69 \pm 1.47\%$ (Can) and $96.44 \pm 3.01\%$ (DBA). The tall instability of Rest, and tall predisposition relative to other bigger PAHs, was suspected to be mindful for its moo recuperation. A littler recuperation rate (36.28%) was detailed for Rest by Karyab et al.(2013). These recuperations were steady and in a few cases generally higher than those detailed in writing (Wei and Jen, 2007; Qiao et al., 2008; Liu et al., 2013; Ma et al., 2013). For occasion, Qiao et al. (2008) detailed recuperation ranges of 62.1 to 106.5% for the USEPA person PAHs in water tests.

Conclusions:

The USEPA-listed PAHs were recognized in water tests collected from the Diep Stream. The Diep Stream streams through distinctive land-use zones; upstream the waterway is overwhelmed by agrarian exercises, and formal and casual settlements as well as mechanical foundations (oil refinery, chemical and clothing industrial facilities, as well as wastewater treatment plant) are the anthropogenic sources of PAHs downstream. Mechanical exercises were major sources of PAH contamination.

The spatial and transient levels of PAHs in water tests from the Diep Waterway appeared regular varieties. The yearly normal recognized levels of chrysene (Chy) and benzo[a]anthracene (BaA) in water tests from all testing locales were higher compared to other PAHs. The surface water tests of the Diep Waterway were intensely sullied with carcinogenic PAHs.

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