

Optimisation of the membrane-assisted passive sampler and its comparison with solid phase extraction technique

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Abstract

A novel membrane-assisted passive sampler was further optimised in the laboratory. It was then compared to the solid phase extraction technique in terms of the extraction efficiency, enrichment factor, detection limit and selectivity in wastewater. The passive sampler was exposed to 3 l wastewater samples under laboratory conditions for 3 days. Five hundred millilitres of wastewater was extracted with C₁₈ cartridges. The extraction efficiency of the passive sampler ranged from 4 to 10% while in solid phase extraction it was 40 to 67% for the 3 chlorophenols. In both cases, extraction efficiency was highest for 2,4-dichlorophenol. The low extraction efficiency in the passive sampler supports the idea that it is not an exhaustive extraction technique and does not disturb the chemical equilibrium of the sample. It therefore measures the bioavailable fraction of the compound and can be used for equilibrium sampling and extraction. The obtained enrichment factors from the passive sampler were 89 and 295 for 2-chlorophenol and 2,4-dichlorophenol, respectively. From solid phase extraction, enrichment factors of 102, 113 and 167 were obtained for 2-chlorophenol, 4-chlorophenol and 2,4-dichlorophenol, respectively. The enrichment factor (~2.5) and sampling rates (~28 µl·h⁻¹) were both low for 4-chlorophenol in wastewater from passive sampler extraction. The calculated sampling rates were found to be 2 604 µl·h⁻¹ for 2-chlorophenol, 1 074 µl·h⁻¹ for 4-chlorophenol and 5 089 µl·h⁻¹ for 2,4-dichlorophenol in spiked deionised water. In wastewater, the sampling rates were found to be 1 544 µl·h⁻¹ for 2-chlorophenol, 28 µl·h⁻¹ for 4-chlorophenol and 5 106 µl·h⁻¹ for 2,4-dichlorophenol. The passive sampler was found to be superior in its selectivity towards the target compounds compared to solid phase extraction technique with C₁₈ sorbent. Chromatograms from solid phase extraction of wastewater contained high peaks of unidentified, potentially interfering compounds, especially in the early part of the chromatogram. In contrast, chromatograms from the passive sampler extraction were very clean. The detection limits of the passive sampler were comparable with that of solid phase extraction and were around 1.5 µg·l⁻¹ except for 4-chlorophenol that was high in wastewater (~100 µg·l⁻¹).

Keywords: passive sampler, solid phase extraction, water monitoring, chlorophenols, selectivity