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Sorptive Bioaccessibility Extraction (SBE) of soils - combining mobilisation medium with absorption sink

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Aim: Incorporate a dominating absorption sink for HOCs into bioaccessibility extraction techniques, in order to maintain the desorption gradient between soil and the mild extraction medium (cyclodextrin / artificial digestive fluid).

Background

- Soil bioaccessibility extractions aim to extract readily desorbing fractions of HOCs. It is crucial to maintain the desorption gradient between soil and extraction medium throughout the extraction. Otherwise desorption might stop and bioaccessibility might be underestimated.

- We propose the combination of mobilization medium with a dominating absorption sink to ensure that the desorption gradient for HOCs is maintained.

Working principle

1. A soil sample is suspended in a mobilization medium and incubated with the absorption sink.
2. The mobilization medium enhances/mimics desorption of HOCs from the soil and transfers them to the sink.
3. The absorption sink is dimensioned to continuously and quantitatively absorb the HOCs from the mobilization medium. This ensures that the desorption gradient is maintained.
4. The HOCs absorbed by sink are solvent extracted and measured by instrumental analysis.

a) The absorption sink:

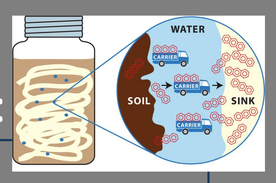
Silicone Rod

Silicone + activated carbon

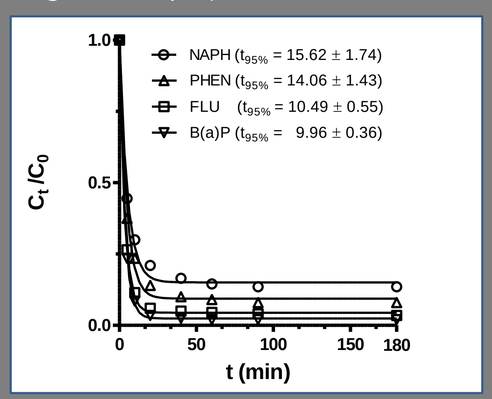
b) The mobilization medium:

- Cyclodextrin solution, microbial bioaccessibility
- Artificial digestive fluid (CEPBET), oral bioaccessibility

Silicone + cyclodextrin[1]:

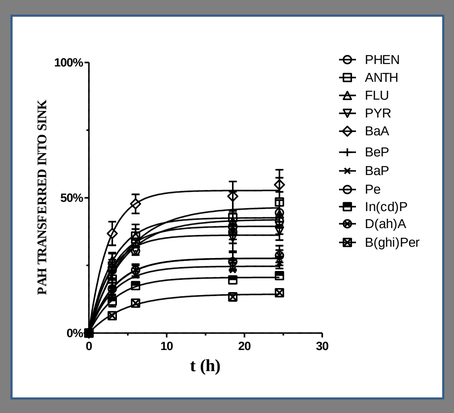


A. Elimination kinetics of PAHs from spiked cyclodextrin solution into the SILICONE ROD (shaking at 300 rpm)

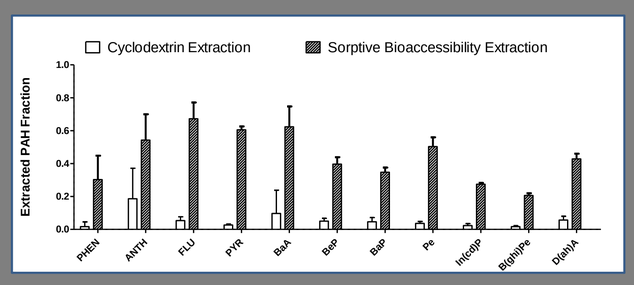


Conclusion: Fast and effective absorption kinetics. The sink can maintain the desorption gradient

B. Application to desorption of pyrogenic PAHs from wood soot. Data show mean (± SD, n=3) of the PAH fraction (%) transferred from soot to the silicone against extraction time.



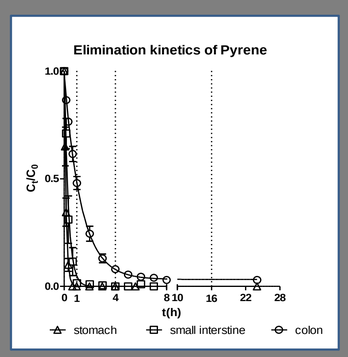
C. PAH fraction extracted from wood soot using Cyclodextrin Extraction method and Sorptive Bioaccessibility Extraction method under identical experimental conditions. Data show mean ± SD (n= 3), extraction time: 2 weeks.



Conclusion: without the sink readily desorbing fraction is underestimated

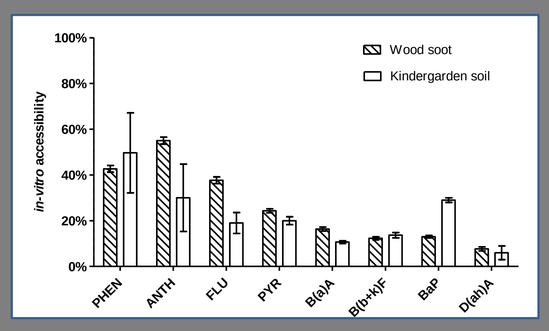
Silicone + artificial fluid[2]:

A. Elimination kinetics of PAHs from spiked artificial fluids into SILICONE ROD. Data show mean PAH fraction left in artificial fluid after time (t) of shaking at 37°C ± SEM (n= 2).



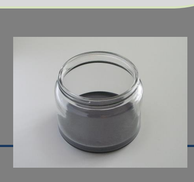
Conclusion: Fast and effective absorption kinetics for each fluid. The sink can maintain the desorption gradient.

B. Measuring *in-vitro* oral accessibility of native PAHs in wood soot and kindergarden soil, data show mean ± SEM (n=3).

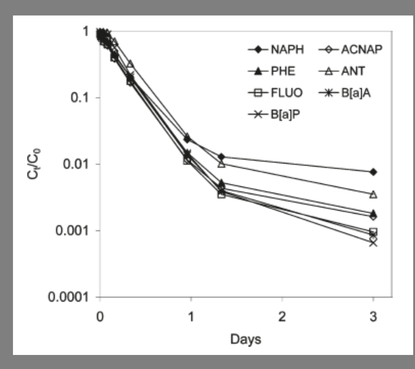


Conclusion: Practical and time efficient method since accessible HOCs were measured in sink extract and not in the complex artificial fluid - No need for phase separation and extract clean up.

Contaminant trap[3]:

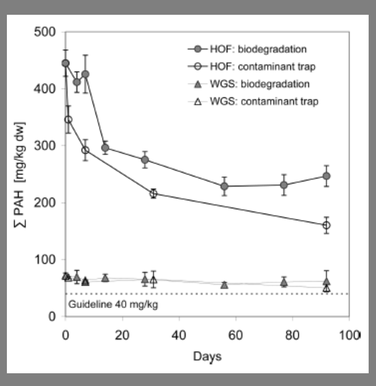


A. Elimination kinetics of PAHs from spiked cyclodextrin solution into the trap (no shaking)



Conclusion: Within the first day of incubation the main PAH fraction was removed from the solution. Sink can maintain the desorption gradient

B. Incubation into the trap vs biodegradation experiment



PAHs concentration remaining in soils during incubation in the traps and during biodegradation experiment was plotted against time

Conclusion: Similar desorption and biodegradation profile, however trap is at the lower boundary.

Conclusions:

› It is possible and necessary to include an infinite absorption sink into bioaccessibility extractions
› Contaminant Trap . A composite of activated carbon and silicone can be used to isolate and quantify desorption resistant pollutants . Very suited for long term desorption studies.
› Sorptive Bioaccessibility Extraction. A silicone rod can act as an efficient sorptive sink that allows for back extraction of accessible contaminants. Additionally, it improves analytics and detection limits.
› Both methods are mild extraction techniques that can maintain the desorption gradient during the extraction.
› Present research indicates that samples with very high K_D values might require absorption sinks with even higher capacity.

References:
1. Gouliarmou V, Mayer P. (2012) Sorptive Bioaccessibility Extraction (SBE) of soils: combining a mobilization medium with an absorption sink. Environ. Sci. Technol. 46: 10682-10689
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3. Mayer P, Olsen JL, Gouliarmou V, Hasinger M, Kendler R, Loibner AP. (2011) A Contaminant Trap as a Tool for Isolating and Measuring the Desorption Resistant Fraction of Soil Pollutants. Environ. Sci. Technol. 2011, 45 (7), 2932-2937.

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