Removal of polycyclic aromatic hydrocarbons by biosorbents

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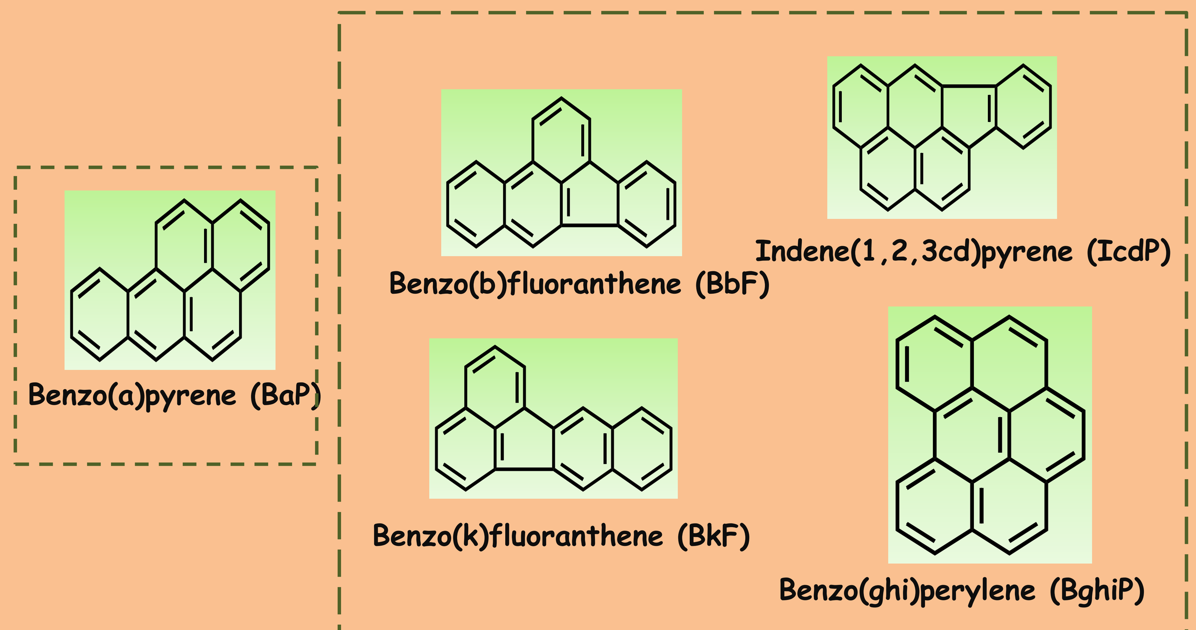
Introduction

- Polycyclic aromatic hydrocarbons (PAHs) are a group of environmental carcinogens. They are formed during the incomplete combustion of organic matter. Humans are exposed to PAHs by various sources, including occupational environments, cigarette smoke, vehicle exhaust, and dietary sources as grilled and flame-broiled food [1,2].
- *In vivo* studies in animals proved that PAHs are associated to cancer, and epidemiologic studies with exposed workers, especially in coke ovens and aluminium smelters, have shown clear excess of lung cancer and highly suggestive excesses of bladder cancer [3,4].
- These compounds can enter in drinking water sources by precipitation and runoff on the earth's surface [5].
- Portuguese legislation for water for human consumption (DL 306/2007) proposes the determination of five PAHs; limits of the maximum concentration are 0.10 µg/L for total BghiP, BbF, BkF, IcdP, and 0.010 µg/L for BaP.

The objective of this work was to evaluate the potentialities of cork as biosorbent for the removal of PAHs from water.

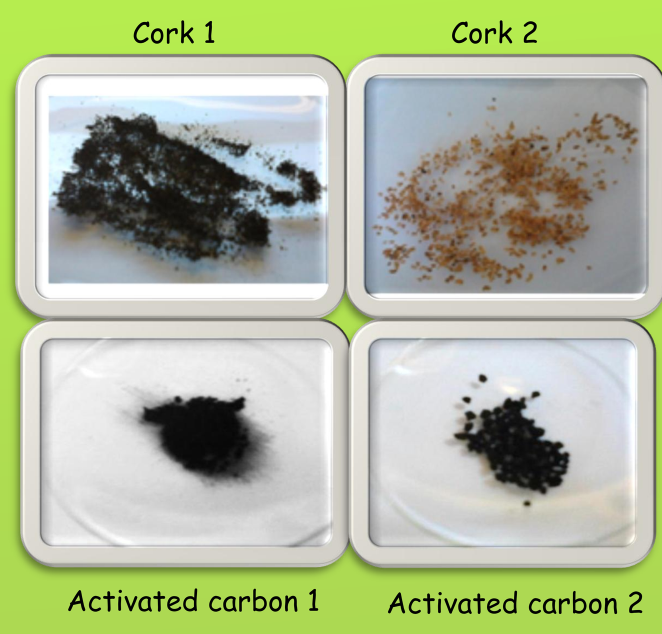
Structures of the PAHs studied



Experimental

Biosorbents samples

cork 1- expanded cork granules, particle dimension (0.25 mm) - supplied by Corticeira Amorim
cork 2- natural cork granules, particle dimension (0.5 - 1mm) - supplied by Corticeira Amorim
activated carbon 1- powdered activated carbon
activated carbon 2- granular activated carbon



Adsorption experiments

- To prevent PAHs photodegradation the vials were covered with aluminium foil
- Stirring: 700rpm
- The assays were performed in duplicate at room temperature

PAHs analysis by SPE-LC- FLD methodology

Method: SPE- solid phase extraction, LC-liquid chromatography with FLD- fluorescence detector wavelengths (295 nm for excitation and 420, 440, 490 nm for emission) using a C18 column and acetonitrile as elution solvent.

SPE procedure: samples were extracted from C18 cartridges using *n*-hexane; this methodology achieved high recoveries (87%).

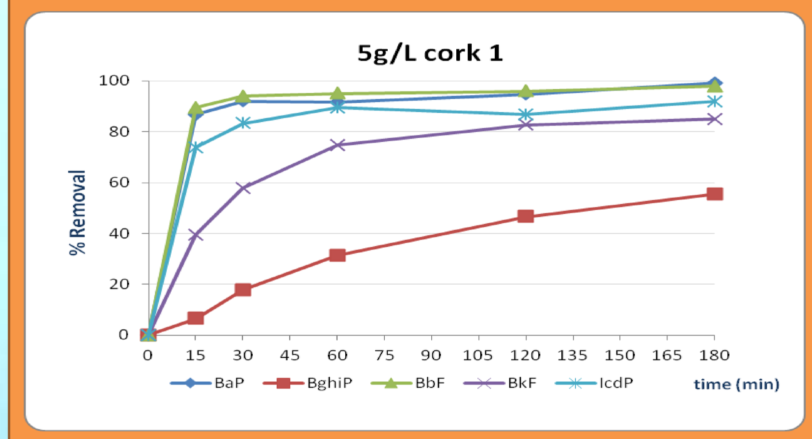
Calibration curve obtained was linear with R^2 = 0,991 in working range.

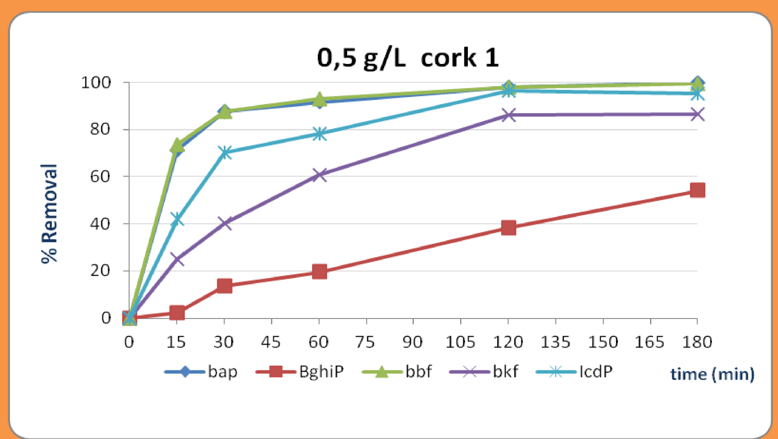
LOQ- 0.004 µg/L ; LOD- 0.001 µg/L

Results and Discussion

Kinetics assays

- **Conditions:** 10 ug/L PAHs Mix + 0.5g/L or 5g/L **cork 1**
- **Contact time:** 15, 30, 60, 120 and 180 min

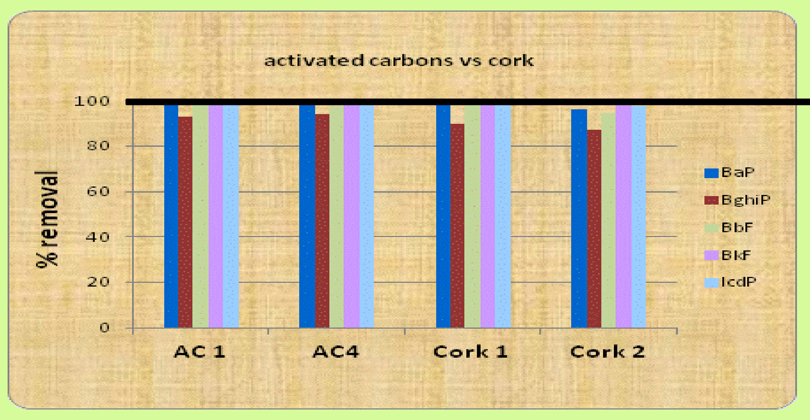




- For all PAHs, but BghiP, after 180 min a removal efficiency between 86- 100% was always obtained.
- As expected the higher amount of cork leads to a faster removal of PAHs; after 60min the removal of BaP (91%), BbF (95%), and IcdP (89%) is pratically complete.

Removal efficiency

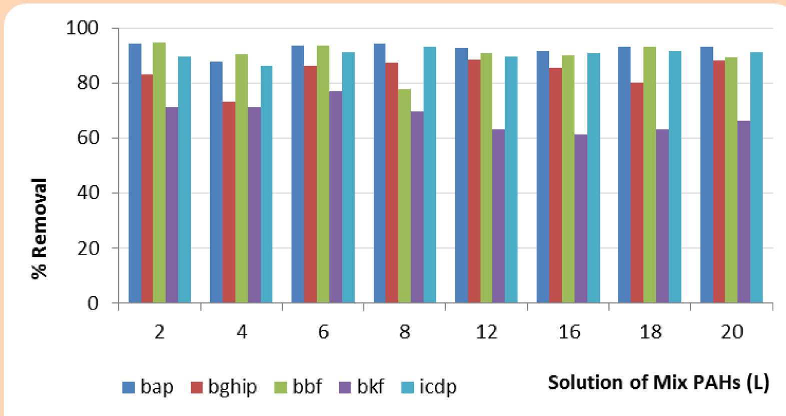
- **Conditions:** 0.1 µg/L PAHs Mix + 5g/L biosorbent
- **Contact time:** 15 min
- These assays were made using a solution of PAHs with a concentration near the legislation limit.

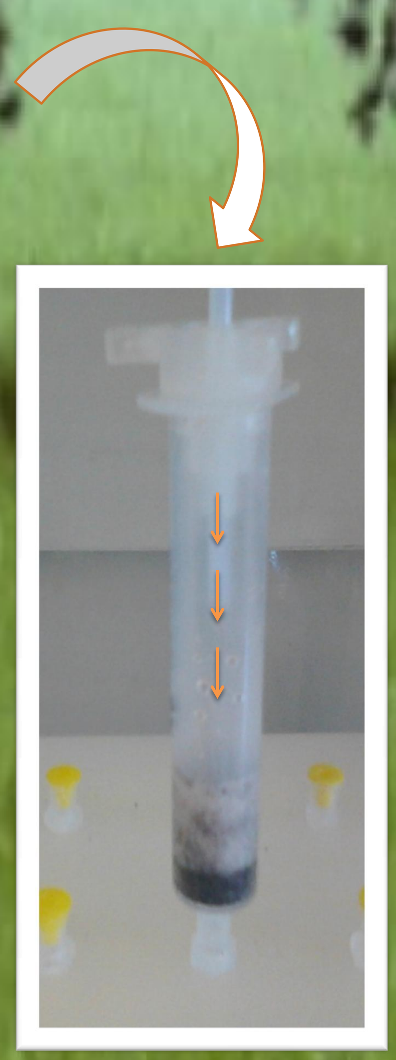


- The results show that cork materials can compete with activated carbon
- Cork 1 allowed complete removal (less than LOQ) for almost all PAHs, and 90% for BghiP

Small scale column tests

- **Conditions:** 0.1 ug/L PAHs Mix + 100 mg cork 1
- Contaminated water with PAHs was passed down through a column at controlled rate





- Even after passing through 20 L of contaminated water with PAHs the removal efficiency was high (almost 70%) for all compounds.

Conclusions

The results obtained show that:

✓Cork materials can compete with activated carbon for the removal of PAHs. This is a great advantage because cork is a renewable and lower cost material.

✓Expanded cork (cork 1) has higher removal capacity than the natural cork (cork 2).

✓The small scale column test induced that cork 1 is a good adsorbent for PAHs removal from water, with higher removal efficiency for all the compounds.

References

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