Drinking Water Contaminants: Toxicity of halogenated polycyclic aromatic hydrocarbons

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Introduction

Food may be contaminated with polycyclic aromatic hydrocarbons (PAHs) in the process of smoking or heating. These contaminants or their derivatives can also be present in drinking water when raw water contacts with discharges of untreated industrial/ waste water effluents, forest fires or by solubilisation of organic material from contaminated soils. A few studies have shown that water disinfection can lead to halogenated derivatives of PAHs (HPAHs) as chlorinated and brominated derivatives, and there are evidences that these compounds may have greater mutagenicity than the parent PAHs.

HPAHs structures

Aims:

Human hazard assessment of chlorinated/ brominated derivatives of **pyrene (Pyr) and benzo[a]anthracene (BaA**) -**1-ClPyr, 1-BrPyr** and **7-ClBaA - through characterization of** the cytotoxic and genotoxic effects in **HepG2 cells**

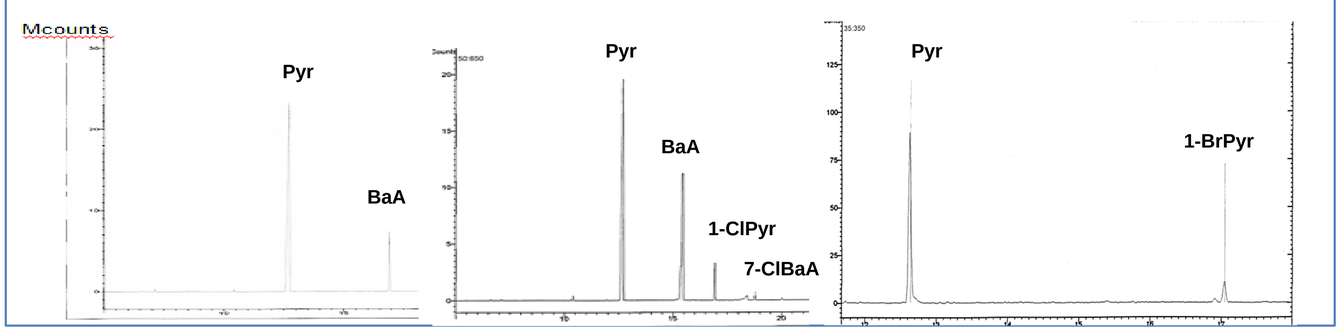
Results and Discussion

Formation of Halogenated Pyren (1-ClPyr, 1-BrPyr) and Benzo(a)anthracene (7-ClBaA) derivatives under aqueous disinfection conditions in waters contaminated with PAHs

Water with Pyr and BaA (3h agitation)

Chlorination (NaOCl, H^+,3h)
or
Bromination (NaOCl,KBr, H^+,3h)

SPME-GC/MS

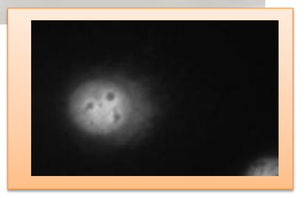


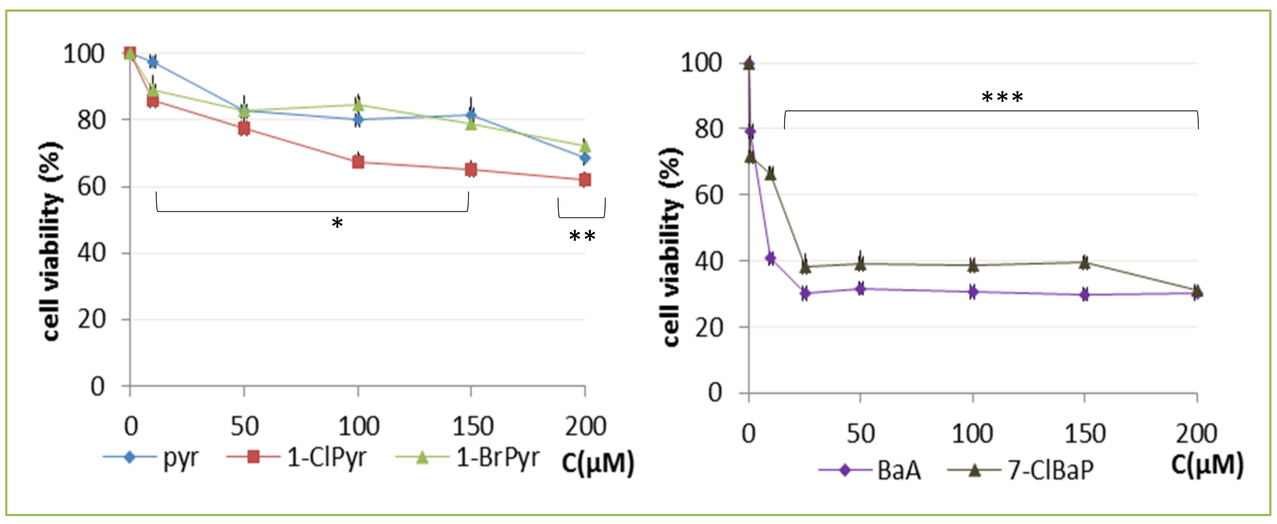
The derivatives were synthetised using:
N-chlorosuccinimide
or
N- bromosuccinimide
in DMF

Evaluation of ciytotoxic and genotoxic effects of chlorinated and brominated derivatives in HepG2 cells

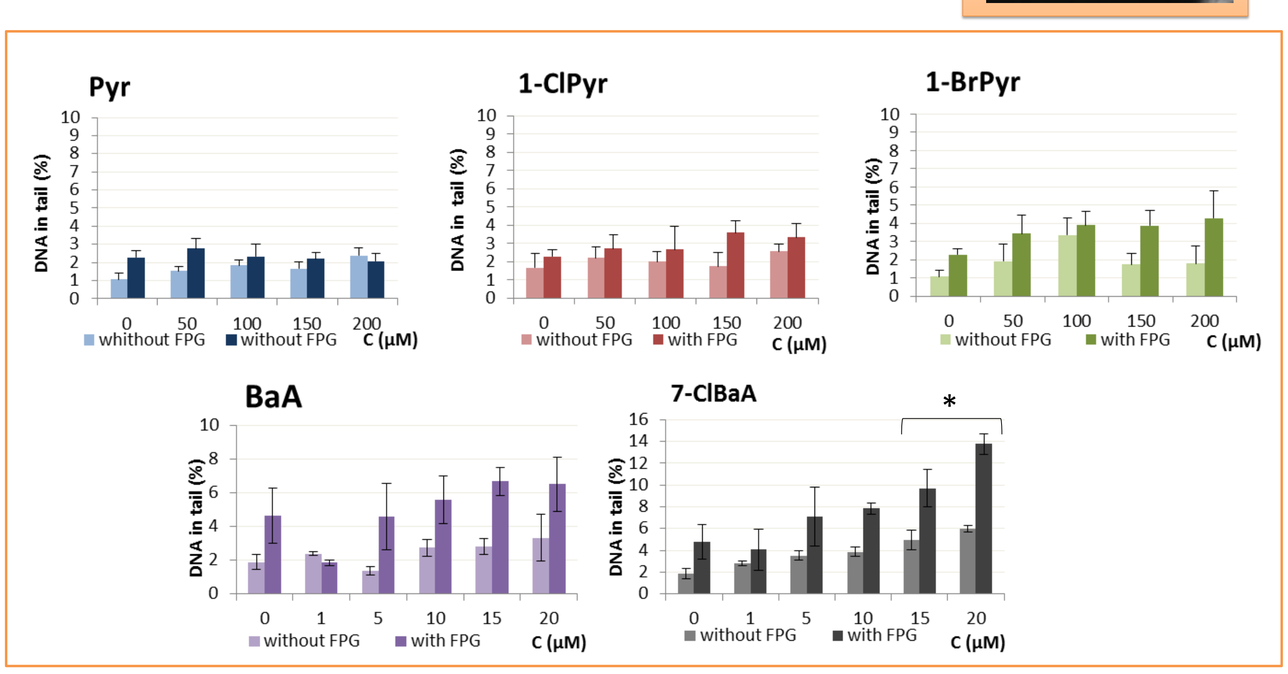
Cytotoxic effects

Genotoxic effects





Results of the neutral red assay 24h exposure to Pyr, 1-ClPyr, 1-BrPyr for concentrations (10 to 200 µM); BaA and 7-ClBaA for concentrations (1 to 200 µM); (* p<0.05; ** p<0.001; ***p<0.0001)



Results of the comet assay and FPG-modified comet assay following 24h exposure to Pyr, 1-ClPyr, 1-BrPyr, for concentrations (50 to 200 µM); BaA and 7-ClBaA for concentrations (1 to 20 µM) ; (* p<0.05)

- **Cell viability > 60% for Pyr and derivatives (1-ClPyr and 1-BrPyr)**
- **Cell viability < 50% for BaA and derivative 7-ClBaA)**

(BaA: IC50 =3.37 µM ; 7-ClBaA: IC50= 12.63 µM)

- **Under these conditions neither Pyr nor its derivatives were genotoxic.**
- **7-ClBaA was able to induce a significantly higher level of oxidative DNA damage in HepG2 cells than BaA**

Conclusions

- **The observation that 7-Cl-BaA can be formed under water disinfection conditions and that it displays a stronger genotoxic potential than BaA, a genotoxic and probable carcinogenic chemical, raises some concern as to the hazard associated to this and other HPAHs that might remain to be identified.**
- **While it is undeniable that disinfection of drinking-water is essential for public health protection, the identification of new possibly hazardous water chlorination by-product emphasizes the need of using raw water with a reduced content of organic carbon and the development of safer water disinfection methods.**

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