FORMATION OF EMERGING DISINFECTION BYPRODUCTS IN WATER AND EVALUATION OF POTENTIAL GENOTOXIC EFFECTS: THE CASE OF HALOGENATED POLYCYCLIC AROMATIC HYDROCARBONS

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Disinfection byproducts (DBPs) are formed when disinfectants used in water treatment plants (WTPs) react with natural (or anthropogenic) organic matter present in the source water. Many studies have addressed health risks posed by a life-time exposure to DBPs through chlorinated drinking water or through dermal or inhalation exposure routes. Experimental studies have revealed genotoxic and carcinogenic effects of some DBPs and epidemiological studies evidenced potential associations between chlorinated drinking water and bladder or colorectal cancer. In addition, a possible link between chlorinated drinking water and reproductive/developmental effects has been hypothesized.

Many DBPs have been identified in chlorinated water, which justifies the growing concern about the potential health effects of emerging unregulated DBPs, some of which appear to be more genotoxic, in some assays, than the regulated DBPs. Polycyclic aromatic hydrocarbons (PAHs) are among the most persistent contaminants detected in environmental samples such as river sediments and tap water. A few studies have already proven that water disinfection can lead to the formation of halogenated derivatives of PAHs, such as chlorinated (Cl-PAHs) and brominated PAHs (Br-PAHs). The available toxicological studies have shown that these compounds possess, in general, greater mutagenicity than the corresponding parent PAHs. Our investigation group have also showed that exposure of HepG2 cells to a dose-range of 6-Cl-benzo[*a*]pyrene (6-Cl-BaP) and BaP resulted in cytotoxicity above 50 µM and that, at the equimolar doses of 100 and 125 µM, 6-Cl-BaP was able to induce a significantly higher level of DNA damage than BaP.

The present study had two main objectives: 1) identification of the major chlorinated and brominated derivatives of benzo[a]anthracene (BaA) and pyrene (Pyr) formed as disinfection by-products and 2) evaluation of their potential hazard to humans, through the characterization of their potential cytotoxic and genotoxic effects in a human cell line. To synthesize Cl-PAHs and Br-PAHs the method of Mitchell was developed for BaA and Pyr. 1-Cl-Pyr and 1-Br-Pyr were obtained as the major chlorinated and brominated derivatives of Pyr, and 7-Cl-BaA and 7-Br-BaA as the reaction products of BaA. Cell viability and DNA integrity of those derivatives were assessed by the neutral red uptake (NR) and the comet assay, respectively, allowing the comparison of their genotoxic potential.

Although health risks of DBPs are small compared to the health risks of waterborne diseases, the formation of hazardous halogenated-PAHs in chlorinated water water emphasizes the need of development of new and safer water disinfection methods.