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Assessment Pollutant Exposure through Hair

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Impact of environmental pollutants on human health has drawn public attention as these chemicals affect human health [1]. To provide an assessment of human exposure to such pollutants is still a challenge to health authority worldwide. Perfluoroalkyl acids (PFAAs), a family of synthetic per fluorinated compounds, comprise of high-energy carbon-fluorine bonds. Their outstanding surfactant properties allow them to be widely used in different industrial and consumer products. However, their highly persistence in our environment leads to their accumulations in wildlife and humans [1].

Human biomonitoring (HBM) is a scientific method of assessing human exposure to environmental xenobiotics. Most of time, this method is based on samples from human tissues and body fluids. It has been a useful tool to monitor the human exposure of group of individuals to pollutants at certain period, or to track the trends of exposure in the whole population over certain periods of time. Collecting blood for human biomonitoring is a common practice. Up to date, blood and breast milk are the most common matrices for PFAAs biomonitoring in human population. However, collecting blood is somewhat invasive and many study participants refuse to donate blood specimens for research purposes, especially from infants or children. Concentrations of PFAAs in breast milk can only provide information concerning the exposure levels of lactating mothers and their babies. Therefore, it is desirable to explore the use of non-invasive samples such as hair, nail and urine. These matrices have been used to provide good indication for human exposure of heavy metals, drugs and organic pollutants in humans [2].

Recently, Alves *et al.* published a paper about using hair as the bio indicator of PFAA exposure [3]. The main advantages of using hair as matrix in HBM are mostly related to the non-invasive sampling, which is easy, fast and not painful. Moreover, the collection is possible for both children/babies and elderly and/or sick people [4]. Also, storage is easy, usually done at room temperature (if the target compounds are not volatile) and for long time period as the matrix stability is higher than for liquid matrices. Further, hair can mirror both the short to long-term exposure (months to years depending on the analyzed hair length), which is considered the major advantage in human exposure assessment [4]. Chemically, PFAAs are different from other POPs, such as organ halogens or polychlorinated biphenyls. Usually most of POPs are lipid soluble and accumulated in lipid. However, PFAAs do not accumulate in lipids but rather bind to protein. Keratin protein, the main component of hair, plays a key role in the accumulation of PFAAs in hair. Hair should be a better alternative to classic invasive sampling.

The main challenge of HBM of PFAAs in human hair is availability of a sufficiently sensitive analytical technique combined with suitable analytical technique combined with suitable extraction methods. Alves *et al.* demonstrated a new, faster and more environmental friendly extraction method to measure 15 short to long PFAAs in hair at pg/g levels by LC/MS [3].

PFAAs are currently extracted from hair by accelerated solvent extraction (ASE) or ultrasound extraction using different organic solvents (e.g., acetonitrile, methanol and acid/basic digestion) [5]. To clean-up the strong acidic compounds, solid-phase extraction (SPE) where weak anion-exchange sorbent combined with a reverse phase (Oasis WAX) is often be performed [5]. Liquid chromatography tandem mass spectrometry (LC-MS/MS) is the most common and more direct analytical approach for measuring PFAAs. The usage of gas chromatography (GC) for PFAAs analysis is limited by the low volatility of PFAAs unless derivatization is performed prior to analysis [5].

In this study [3], Alves *et al.* demonstrated that ethyl acetate (EA) was the best extraction solvent (% R from 69% to 141%) despite of good recoveries observed from the other two solvents tested, 2-propanol or 50/50% (v/v) of THF/2-propanol. The authors suggested the EA as the most suitable extraction solvent for extracting the PFAAs because of (1) the higher precision obtained in the triplicate spiking experiments for both PFAAs (RSD%<4.4%) and internal standards (RSD%<15%) (2) the high PFAA extraction performance in overall from the hair matrix, which was almost 100% (for more than half of the analytes) and (3) the low boiling point of the EA that can minimize losses of PFAAs during the evaporation of the extracts.

The clean-up step after solvent extraction is vital because this step aims in removing interferences present in the extracts to avoid matrix effects during LC-MS/ MS analysis. Although SPE Oasis WAX has been previously reported to remove interferences efficiently from hair [5], the study by Alves *et al.* demonstrated that good recoveries by SPE Oasis WAX were limited in short-chain PFAAs instead of the long-chain PFAS (poor recoveries of 58%, 56% and 35% were assessed for PFNS, PFDS and PFDoS, respectively) [3]. In addition, Alves *et al.* demonstrated that the dispersive ENVI-Carb showed the best recoveries from the hair (>87% for the studied PFAAs) [3]. These results are consistent with other previous studies that the high efficiency of dispersive ENVI-Carb has been found during the detection of PFAAs in environmental matrices such as dust, soil, sediments, sludge or in biological matrices like blood, serum, plasma or milk [5]. Finally, other factors such as hair type and matrix effect influence in the PFAAs detection were also evaluated for this study [3].

This study provides a new approach for assessing human PFAA exposure via hair although this method still requires extensive populations to confirm its applicability.

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Conflict of Interest

The author declared no competing interests.

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