Organophosphorus flame retardants in Swedish house dust

Dahlberg A-K[1,2] and Weiss J. M[1,2]

[1] Dept. of Environmental Science and Analytical Chemistry, Stockholm University, Sweden.

[2] Dept. of Aquatic Sciences and Assessment, Swedish University of Agricultural Sciences, Sweden

Introduction

The addition of flame retardants efficiently reduces the flammability of materials and products. Brominated organic flame retardants such as polybrominated diphenyl ethers (PBDEs) have been widely used for decades. However, due to their toxicity and persistence in the environment, their use is nowadays banned or restricted (UNEP, Stockholm Convention on POPs). This has resulted in increased use of alternative flame retardants, such as organophosphorus flame retardants (OPFRs), which are also used as plasticizers and stabilizers and found in a various products such as building materials, electronics and furnishing materials (Wypych 2004).

Given that OPFRs are incorporated in such a variety of materials and products, sampling of dust provide a good matrix to assess the overall exposure of OPFRs in the indoor environment. Inhalation and dermal contact to dust has also been identified as an important exposure pathway for flame retardants to humans (Lorber *et al.* 2008) and small children in particular, given their frequent hand-to-mouth activity (Stapleton *et al.* 2008).

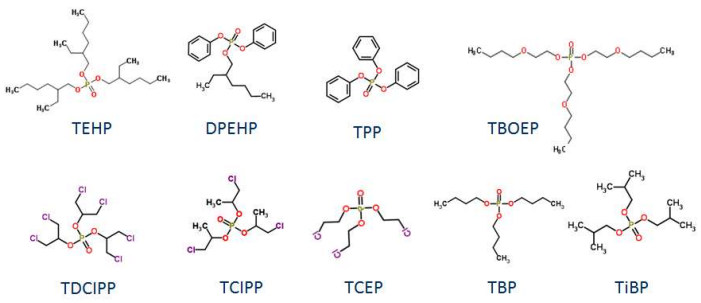

Figure 1. Organophosphorus flame retardants analysed.

Material & Methods

Samples

Indoor dust samples from seventeen Swedish homes were collected using a Dustream™ dust collector (Indoor Biotechnologies Ltd., Wiltshire, United Kingdom) containing a disposable filter (mesh size 40 µm) attached on a household vacuum cleaner tube. The dust samples were further sieved (mesh size 1 mm) prior to extraction. Fifteen individual dust samples collected from living rooms and three samples containing dust collected from living room and bedrooms, were analysed along with indoor house dust (SRM 2585) purchased as standard reference material from the US National Institute of Standards and Technology (NIST, Gaithersburg, USA).

Extraction and clean up

House dust (50 mg) was extracted and fractionated according to a slightly modified method by Van den Eede *et al.* (2012). Prior to extraction deuterium-labelled TCEP was added as surrogate standards to each sample. Shortly described; the extraction was performed using 2mL *iso*-hexane:acetone (3:1, v/v), vortexed (1 min) and ultrasonicated (10 min). After centrifugation (10 min, 3000 rpm), the liquid phase was transferred to a new test tube and the pellet re-extracted twice as described. The liquid phases from each extraction cycle were combined (6 mL) and evaporated to near dryness under a gentle stream of nitrogen and reconstituted in 0.5 mL *iso*-hexane. Each sample was then fractionated on a Florisil SPE cartridge which had been pre-cleaned with 10 mL *iso*-hexane before applying the sample. A fraction (F1) containing PBDEs and PCBs was eluted with 10 mL *iso*-hexane and saved for future analysis. The OPFRs were then collected by elution with 10 mL ethyl acetate in a second fraction (F2). This fraction was gently evaporated to near dryness under a gentle stream of nitrogen and reconstituted in in toluene (0.5 mL). Prior to instrumental analysis, TPEP was added as volumetric standard.

Instrumental analysis

The samples were analysed using a gas chromatograph coupled to a nitrogen phosphorous detector (GC-NPD, Agilent 6890). The injector (held at 300ºC) was operated in splitless mode and the analytes were separated on a DB5 capillary column (30 m x 0.32 mm i.d. x 0.25µm film thickness; J&W Scientific). The temperature program for the column oven was: 100ºC for 1.5 min, 10ºC/min to 270ºC (2 min) and 20ºC/min to 300ºC (5min). The NPD detector temperature was set at 350ºC . Identification and quantification was performed using authentic reference standards.

References

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Aim

The aim of this study was to determine the concentration of organophosphorus flame retardants (OPFRs) in house dust from Swedish homes within the framework of the MISSE project. MISSE is investigating the mixtures of several endocrine disrupting chemicals (EDCs) in the indoor environment, with special focus on thyroidogenic compounds.

Results

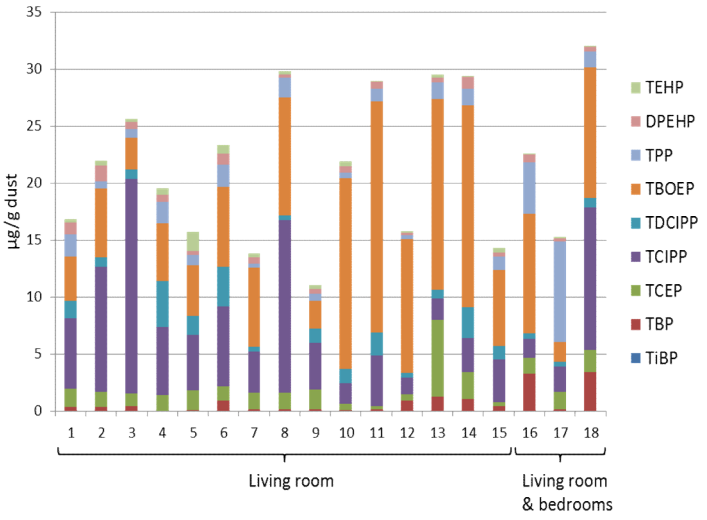

Figure 2. Concentration of organophosphorus flame retardants (µg/g dust) in house dust from Swedish homes.

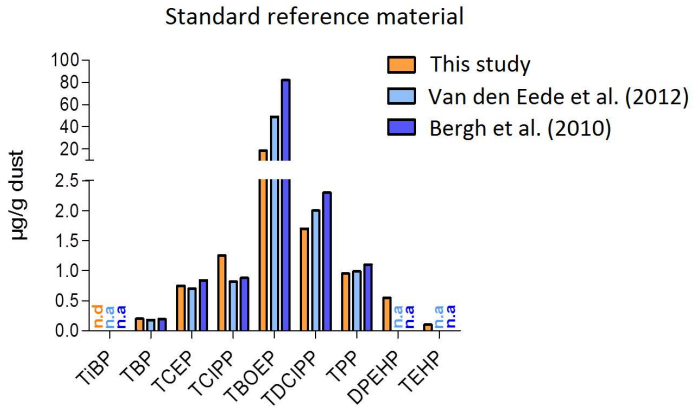

Figure 3. Reported concentrations of organophosphorus flame retardants (µg/g dust) in indoor house dust purchased as standard reference material (SRM 2585) by different studies.

Conclusions & future perspectives

This study gave insight of concentrations and compound profile of OPFRs in house dust from Swedish homes. The samples were analyzed as part of the research project MISSE which aims to assess the exposure situation of anthropogenic thyroid hormone disrupting compounds in the indoor environment using cats as sentinels for human and child exposures to indoor related chemicals and to assess their thyroidogenic effects. More information can be found on the projects website: http://www.aces.su.se/misse/.

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Dept. of Environmental Science and Analytical Chemistry
Stockholm University
Svante Arrhenius väg 16
SE-106 91 SWEDEN

t +46 8 16 37 81
e jana.weiss@aces.su.se
i http://www.aces.su.se/misse/

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