BROMINATED FLAME RETARDANT LEVELS IN TREATMENT PLANT SLUDGES OF TURKEY

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Abstract

*This study depicts the first brominated flame retardant (BFR) levels in wastewater treatment plant (WWTP) sludges from Turkey. Polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecane (HBCDD) were frequently used BFRs in commercial goods which can easily leach from the applied products and find their way into environmental media and biota. Due to their persistency and potential toxicity, knowledge of their levels in WWTP sludges is of great concern regarding the sludge disposal and reuse. Within the scope of this study, 2 urban and 2 industrial WWTP sludge samples were collected in warm and cold seasons. Total PBDE and HBCDD concentrations were found as 66.9 – 2.46*107 ng/g, and 13.1 – 616.2 ng/g, respectively. These are some of the highest reported levels in the literature.*

Keywords

Polybrominated diphenyl ethers; hexabromocyclododecane; persistent organic pollutants.

INTRODUCTION

PBDEs and HBCDD are widely distributed and persist in the environment, and are potentially toxic and bioaccumulative. Their technical mixtures were identified as persistent organic pollutants by Stockholm Convention (Stockholm Convention, 2017) and as priority hazardous substances by Water Framework Directive (European Commission, 2013). Therefore, determination of BFR usage in a country is crucial for environmental compliance. There is currently no information about the levels of PBDEs and HBCDD in WWTP sludges in Turkey. Hence this is the first study reporting these levels which directly represent the amount and areas of usage of these chemicals.

MATERIALS AND METHODS

Dewatered sludge samples were collected from WWTPs located in four different geographical regions of Turkey. Two urban (U-1, U-2) and two industrial (I-1, I-2) WWTPs were selected to represent urban and industrial usage of these BFRs in two sampling campaigns: cold and warm. Samples were dried in a lyophilizator, then were ground and sieved through a 2.0-mm sieve. Sludge samples were extracted via ultrasonic extraction. After being concentrated in rotary evaporator, extracts were purified with sulphuric acid and then

alumina. Purified extracts were finally concentrated via nitrogen evapo
or rotary evaporator. PBDEs were analyzed in gas chromatography c
with electron capture detector (GC-ECD), and HBCDD was analyzed ir
chromatography tandem mass spectrometry (LC-MS/MS).

RESULTS AND DISCUSSION

Total PBDE levels in sludges were found minimum in U-1-warm
ng/g) and maximum in U-2-cold samples (655.37 ng/g) for urban V
and minimum in E-1-warm (66.93 ng/g) and maximum in E-2-cold
(2.46*107 ng/g) for industrial WWTPs. Cumulative percent distrib
PBDE homologs in each sludge sample is presented in Figure 1,
with that of commercial PBDE mixtures (La Guardia et al., 2006), and
background PBDE profiles obtained from the literature (Jarkovsky et
Odabaşı et al., 2015). The percent contribution of PBDE congener
and warm seasons were similar for the same WWTP. Contributio
mixture is apparent for urban WWTPs since deca-BDE was the most
congener in sludge samples. Presence of lower brominated congen
urban sludge samples revealed the usage of penta-, and octa-BDE
deca-mixture-treated household products such as TV/PC housing
and furniture textiles (Alaee et al., 2003). Also, I-2 samples obvious
deca-mixture use during manufacturing in the industrial zone, mai
of which are automotive industry accessories, upholstery for car cu
insulation materials. These are major usage areas of PBDEs (Alaee e
I-1 sludge sample congener profiles resemble that of Turkey's
samples. This is consistent with manufacturing in this industrial
towels and bed sheets are produced, which are not among typical
of PBDEs.

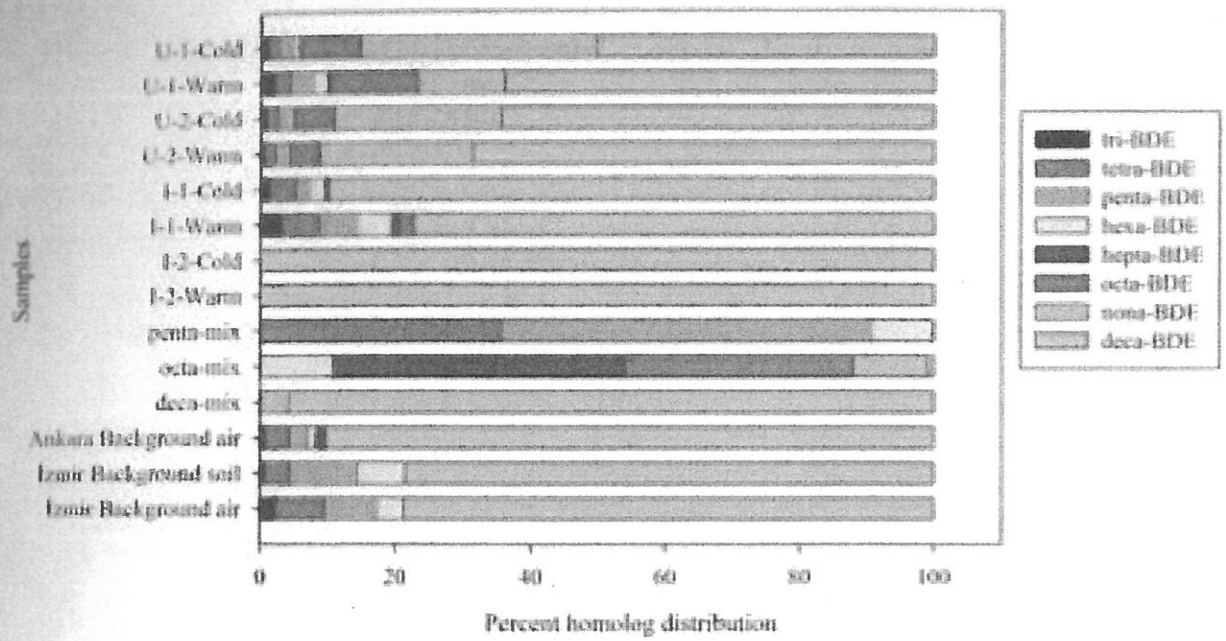

Figure 1. *PBDE homolog distribution of sludge samples.*

HBCDD levels in sludges were found minimum in U-1-cold (75.4 ng/g) and maximum in U-2-cold samples (616.2 ng/g) for urban WWTPs, and minimum in E-1-cold (13.1 ng/g) and maximum in E-2-cold samples (415.8 ng/g) for industrial WWTPs. Levels imply that HBCDD is not directly applied to the manufacturing products of industries that WWTPs serves for, but rather represent the usage of HBCDD-applied commercial products in residential and industrial areas.

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