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Promotion of International Harmonization of Analytical Methods for Environmentally Sound Management of Plastic Wastes Containing Newly Listed POPs

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Considering certain newly listed persistent organic pollutants (POPs), for this study we developed a rapid simplified method of quantifying polybrominated diphenyl ethers (PBDEs) and hexabromocyclododecanes (HBCDs) in plastic waste using gas chromatography coupled with a quadrupole mass spectrometer (GC/MS) or electron capture detector (GC/ECD) (Eguchi et al., 2021). In addition, we developed a novel analytical method of quantifying short-, medium-, and long-chain chlorinated paraffins (SCCPs, MCCPs, and LCCPs) in plastic wastes using liquid chromatography/electrospray ionization-tandem mass spectrometry (LC/ESI-MS) (Matsukami et al., 2020). The methods we developed are capable of identifying plastic wastes containing these chemicals above the low-POP-content limits proposed by the Parties to the Basel Convention. To evaluate the accuracy of our GC methods and to disseminate these methods as widely as possible so as to promote proper management of plastic wastes containing POPs, we conducted two interlaboratory studies with 35 national and international participant institutions (Fig. 1). A total of 11 test samples, including standard solutions, plastic waste extracts and pieces of plastic waste containing PBDEs and HBCDs were distributed to the participants for chemical analysis using two different analytical methods: the usual in-house methods used at each laboratory and the simplified methods we had

	1st Round in 2019	2nd Round in 2020			
Test samples	Standard solutions and plastic extracts 	CRT TV casing 	Car fabric 	Insulation boards (EPS and XPS) 	Extracts of automobile shredder residue (ASR) 
Target compounds	PBDE and HBCD	PBDE		HBCD	PBDE and HBCD
Participants	35 laboratories at universities, research institutes and private companies in Belgium, China, Germany, India, The Netherlands, UK, US, Kuwait and Japan	26 laboratories at universities, research institutes and private companies in Belgium, China, Germany, India, South Korea, the Netherlands, USA and Japan			

Fig. 1 Interlaboratory studies for PBDEs and HBCDs in plastic waste.

developed. The relative standard deviations for both PBDE and HBCD concentrations in the test samples were comparable between the two types of methods, validating our simplified methods.

The occurrence of PBDEs and CPs was assessed in a wide range of samples, such as consumer products, E-waste plastic mixtures, automobile shredder dust and recyclates, to evaluate the current status of their intentional use and unintentional contamination (McGrath et al., 2021; Kajiwara et al., 2022). The results obtained with the novel analytical method for CPs did not differ significantly from those measured using conventional ultra-high-resolution instruments, indicating the usefulness of our method. Among plastic waste generated in Japan, the PBDE contents of end-of-life cathode ray tube television casings were prominent, suggesting a need for control measures to prevent them from being used in recycling feedstocks. In addition, we conducted a series of onsite surveys at landfills and waste recycling facilities in Japan to elucidate the environmental emission dynamics of microplastics containing PBDEs. At controlled landfills, waterborne emissions of microplastics containing PBDEs were small, and their impact was minor. Airborne emissions of microplastics from waste recycling facilities were also small, but PBDE emissions were similar to those from home appliance waste and E-waste recycling plants.

<Journal articles>

Eguchi et al. (2021) Simultaneous determination of polybrominated diphenyl ethers and hexabromocyclododecane in plastic waste by short-column gas-chromatography-quadrupole mass spectrometry and electron capture detector. *Chemosphere*, 277: 130301.

Kajiwara et al. (2022) Recycling plastics containing decabromodiphenyl ether into new consumer products including children's toys purchased in Japan and seventeen other countries. *Chemosphere*, 289: 133179.

Matsukami et al. (2020) Liquid chromatography-electrospray ionization-tandem mass spectrometry for the determination of short-chain chlorinated paraffins in mixed plastic wastes. *Chemosphere*, 244: 125531.

McGrath et al. (2021) Short- and Medium-Chain Chlorinated Paraffins in Polyvinylchloride and Rubber Consumer Products and Toys Purchased on the Belgian Market. *International Journal of Environmental Research and Public Health*, 18(3): 1069.