EVIDENCE OF POLYBROMINATED BIPHENYL ETHERS (PBDEs) IN ANTARCTICA: CURRENT SITUATION AND PERSPECTIVES

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Introduction

The Antarctic region covers about 20% of the Southern Hemisphere and the Antarctic Peninsula is the northernmost part of the mainland of Antarctica[1]. Human activities in Antarctica are primarily regulated by the complex of multilateral agreements of the Antarctic Treaty System, in particular the Antarctic Treaty itself and its Madrid Protocol on Environmental Protection, SCAR (Scientific Committee on Antarctic Research), and GOSEAC (SCAR Group of Specialists on Environmental Affairs and Conservation). Persistent Organic Pollutants (POPs) are a global environmental concern, have long been identified as harmful substances due to their toxicity, persistence and bioaccumulation in humans and wildlife[2]. Evidences indicated that most POPs are volatile enough to evaporate and deposit (i.e., cycle) among air, water, and soil at ordinary environmental temperatures[3]. They are also persist and therefore can travel a long distance through atmospheric transportation, even reach the Polar Regions. Through ice melting, POPs are released again into the ocean, where they enter the food webs, bioaccumulate in the tissues of organisms and biomagnification[4]. PBDEs are compounds that have been widely used as flame retardants[5]. Because of their toxic effects PBDEs commercial mixtures Penta-BDE and Octa-BDE have been banned by the Stockholm Convention[6]. Nevertheless, the knowledge of PBDE levels in the Antarctic environment is still scarce. Consequently, the aim of this study was to revise the scientific literature for PBDEs in Antarctica, in order to identify gaps of information and to address future research to well understand their source, such as their fate and long range transport.

Material and Methods

In order to carry out this PBDEs review in Antarctica, 60 scientific articles were collected by using the scientific literature dated from 2004 to 2016. To better understand the information obtained, the information was separated by environmental compartments. The literature review showed a wide range of analytical techniques available to determine PBDEs. Different types of matrices analyzed (a) and the analytical methodologies used (b) were shown in Figure 1. Sample purification was carried out using two types of clean up procedures.

Results and Discussion

Analytical methods.

This literature revision showed that Soxhlet System (55%) is the most used technique for extraction of samples followed by Accelerated Solvent Extraction (27%), Pressurized Liquid Extraction (12%), Microwave-assisted extraction (3%) and Ultrasonic Bath (3%). The purification of the extract was mainly performed using a glass column packed with silica gel and alumina (87%) and Power Prep System (13%).

Biotic sample.

From the 60 collected studies, 56% of them corresponded to PBDEs in the biotic samples of Antarctica including organisms and vegetables such as: moss and lichens (10%) and 44% corresponded to PBDEs in abiotic. It is important to clarify that Antarctic biota mostly refers to marine organism; the territorial species of flora and fauna are very few, represented by: lichens, moss and small invertebrates[7]. PBDE patterns showed, for biotic samples, prevalence of lower brominated compounds (PBDE-47, -99, -100) and for abiotic media, an enrichment composition of higher brominated compounds (PBDE-209). Levels of PBDEs (pg/g l.w) have been reported in the lowest levels of the Antarctic food web in Krill (*Euphasia superba*) for PBDE-47 (2000), PBDE-99 (2500) and PBDE-100 (500) from west Antarctica Peninsula[8]. For higher food web levels, PBDE-47 (140 and 180 pg/g l.w) was reported in five fish species: *Trematomus bernacchii, Chionodraco hamatus, Chaempsocephalus gunnari, Gymnoscopelus nicholsi and Trematomus eulepidotes*, from the Ross sea[9, 10, 11].

Recently, Cincinelli et al[12] reported an increasing trend of PBDEs levels from 2000 until 2005 followed by a decreasing pattern from 2005 to 2011[12]. PBDEs were also observed in migratory birds such as *Stercorarius*

maccormicki[12] (46 ng/g w.w) and in Adélie penguins (*Pygoscelis adelie*) (in muscle 6.8 ng/g w.w and in eggs 8.1 ng/g w.w) from the Ross Sea[13].

Abiotic samples

From the revised literatures, soil was observed to be the most studied media (12%) followed by air (10%), sediments (10%) and snow (6%). In soil samples, PBDE patterns were dominated by BDE-209 (35%)[14]. In addition, BDE-47, BDE-99 (20%) and BDE-100 (<10%) were reported in snow samples (130-340 pg/L), in water (Σ_{13}PBDEs: 60-151 pg/L) and in sediments (193-1682 pg/g) from Northern Victoria Land[14]. PBDEs concentrations were also reported in air using PUF disk in five sites near to Great Wall station (King George Island) (0.67-2.98 pg/m^3)[15].This study pointed out there is still a lack of information for PBDEs in the Antarctic environment with a prevalence of studies in biotic media. Further information is still need to assess PBDE levels and patterns in Antarctica.

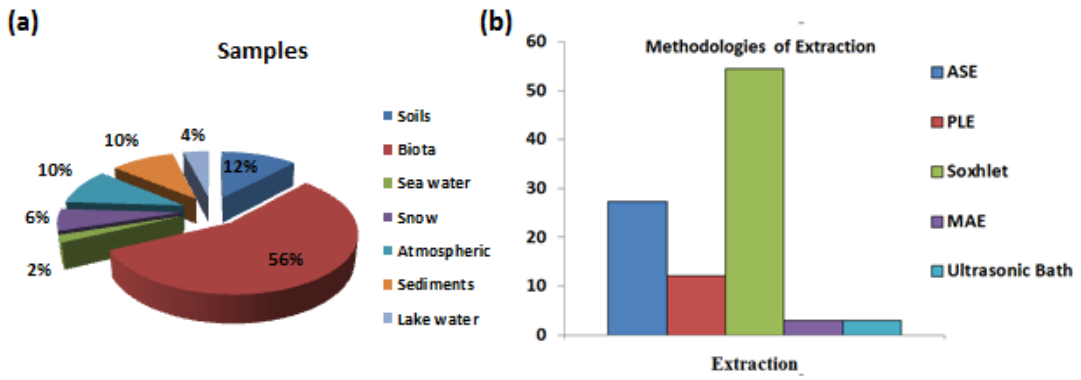

Figure 1. Shows the percentage (%) of different types of samples analyzed in the current scientific literature available (a) and the different methodologies of extraction (b).

Acknowledgements

The authors thanks project Fondecyt 1161673 (PI: Karla Pozo) in Chile. This research was supported by the National Sustainability Programme of the Czech Ministry of Education, Youth and Sports (LO1214) and the RECETOX research infrastructure (LM2015051). The Italian National Antarctic Research Programme (PNRA) funded this research (PdR2013 C1_04).

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