Environment International 77 (2015) 116–131

Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

Review

Brominated flame retardants and seafood safety: A review

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ARTICLE INFO

Article history:
Received 17 June 2014
Received in revised form 29 December 2014
Accepted 4 January 2015
Available online xxxx

Keywords:
Brominated flame retardants
Polybrominated diphenyl ethers
Contaminants
Seafood
Food safety

ABSTRACT

Brominated flame retardants (BFRs), frequently applied to industrial and household products to make them less flammable, are highly persistent in the environment and cause multi-organ toxicity in human and wildlife. Based on the review of BFRs presence in seafood published from 2004 to 2014, it is clear that such pollutants are not ideally controlled as the surveys are too restricted, legislation inexistent for some classes, the analytical methodologies diversified, and several factors as food processing and eating habits are generally overlooked. Indeed, while a seafood rich diet presents plenty of nutritional benefits, it can also represent a potential source of these environmental contaminants. Since recent studies have shown that dietary intake constitutes a main route of human exposure to BFRs, it is of major importance to review and enhance these features, since seafood constitutes a chief pathway for human exposure and biomagnification of priority environmental contaminants. In particular, more objective studies focused on the variability factors behind contamination levels, and subsequent human exposure, are necessary to support the necessity for more restricted legislation worldwide.

Contents

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http://dx.doi.org/10.1016/j.envint.2015.01.001

1. Introduction

Seafood is one of the most important food commodities worldwide, both from economical and nutritional points of view, with Europe as the leading continent in seafood consumption (FAOSTAT, 2013). Regardless the health benefits of a seafood rich diet, which have been extensively recognized (Loret, 2010), it can also be a source of pernicious environmental contaminants, thereby providing a major pathway for human exposure and biomagnification (Marques et al., 2011). Therefore, several governmental and health authorities became highly concerned with seafood quality and safety, increasing regulation for specific contaminants and supporting the development of specific actions regarding major sea-related challenges. The assessment of safety issues related to non-regulated priority contaminants and the evaluation of their impact on public health and environment have become mandatory.

In order to define the priority pollutants and strategic actions, Rotterdam Convention, assembled in 1998, aimed to define guidelines for the import and use monitoring of 14 hazardous chemicals (RC, 1998). Currently, there are a total of 47 substances (33 pesticides and 14 industrial chemicals) under Rotterdam Convention surveillance (RC, 2011).

Furthermore, the Stockholm Convention on Persistent Organic Pollutants (POPs) was assembled in 2001, under the management of the United Nations Environment Program. As a result, a list of the 12 worst pollutants was laid down in 2006, known as the "Dirty Dozen" (SCPOP, 2006), which was further updated with 10 new contaminants (SCPOP, 2009, 2011).

As to the marine environment, and in accordance with the European Union (EU) Marine Strategy Framework Directive (MSFD) (Directive 2008/56/EC) adopted in 2008, the "Priority Contaminants" concept embraces all harmful contaminants in seafood that might constitute a risk for human health and for which there is insufficient scientific knowledge. It includes substances for which no maximum levels have been laid down yet (in EU legislation or international standards), as well as substances for which maximum levels have been provided but require revision. In 2010, the MSFD group 9, compiled the regulatory levels for some substances, including heavy metals (lead, cadmium and mercury), polycyclic aromatic hydrocarbons, polychlorinated dibenzo-*p*-dioxins, polychlorinated dibenzofurans, dioxin-like polychlorinated biphenyls (PCBs), and radionuclides, and established seven classes of compounds as chief priority contaminants, ordered according to priority as: 1) Non-dioxin-like polychlorinated biphenyls (congeners #28, 52, 101, 138, 153 and 180); 2) brominated flame retardants (BFRs); 3) polyfluorinated compounds; 4) arsenic (total and inorganic); 5) organotin compounds (tributyltin, triphenyltin, dibutyltin); 6) organochlorine pesticides (chlordane, dichlorodiphenyltrichloroethane, dicofol, endosulfan, heptachlor, aldrin, dieldrin, endrin, hexachlorocyclohexane, toxaphene, hexachloro-benzene), and 7) Phthalates (benzylbutylphthalate, dibutyl phthalate, di-2-ethylhexyl phthalate, diisodecyl phthalate, diisononyl phthalate, diisobutyl phthalate) (Swartenbroux et al., 2010). Since non-dioxin-like PCBs are already being regulated and thoroughly monitored (ECR, 2001; 2006a, 2011, 2012a), BFRs rise first on the list as priority contaminants. The lack of regulation and monitoring of these pollutants in seafood makes their assessment urgent and imperative.

BFRs are chemicals commonly added for many years to a wide variety of industrial and household products to improve their fire resistance, and include diverse chemical classes of compounds. Their widespread