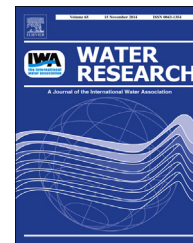




ELSEVIER

Available online at www.sciencedirect.com

ScienceDirect

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

Review

Occurrence, fate and behavior of parabens in aquatic environments: A review



Camille Haman¹, Xavier Dauchy*, Christophe Rosin, Jean-François Munoz

ANSES, Nancy Laboratory for Hydrology, Water Chemistry Department, 40 rue Lionnois, 54000 Nancy, France

ARTICLE INFO

Article history:

Received 18 August 2014

Received in revised form

23 September 2014

Accepted 24 September 2014

Available online 5 October 2014

Keywords:

Parabens

Wastewater

Drinking water

Freshwater

Halogenated by-products

Emerging contaminants

ABSTRACT

Parabens are esters of para-hydroxybenzoic acid, with an alkyl (methyl, ethyl, propyl, butyl or heptyl) or benzyl group. They are mainly used as preservatives in foodstuffs, cosmetics and pharmaceutical drugs. Parabens may act as weak endocrine disrupter chemicals, but controversy still surrounds the health effects of these compounds. Despite being used since the mid-1920s, it was only in 1996 that the first analytical results of their occurrence in water were published. Considered as emerging contaminants, it is useful to review the knowledge acquired over the last decade regarding their occurrence, fate and behavior in aquatic environments. Despite treatments that eliminate them relatively well from wastewater, parabens are always present at low concentration levels in effluents of wastewater treatment plants. Although they are biodegradable, they are ubiquitous in surface water and sediments, due to consumption of paraben-based products and continuous introduction into the environment. Methylparaben and propylparaben predominate, reflecting the composition of paraben mixtures in common consumer products. Being compounds containing phenolic hydroxyl groups, parabens can react readily with free chlorine, yielding halogenated by-products. Chlorinated parabens have been detected in wastewater, swimming pools and rivers, but not yet in drinking water. These chlorinated by-products are more stable and persistent than the parent species and further studies are needed to improve knowledge regarding their toxicity.

© 2014 Elsevier Ltd. All rights reserved.

Contents

1. Introduction	3
2. Chemistry, production and discharges	3
3. Removal efficiency of parabens at wastewater treatment plants	4
4. Fate and behavior of parabens in aquatic environments	5

List of abbreviations: BuP, Butylparaben; BzP, Benzylparaben; EtP, Ethylparaben; HeP, Heptylparaben; i-BuP, Isobutylparaben; i-PrP, Isopropylparaben; MeP, Methylparaben; p-HAB, p-hydroxybenzoic acid; PrP, Propylparaben; WWTP, Wastewater Treatment Plant; REACH, Registration, Evaluation, Authorization and Restriction of Chemicals.

* Corresponding author. Tel.: +33 383 38 87 20; fax: +33 383 38 87 21.

E-mail address: xavier.dauchy@anses.fr (X. Dauchy).

¹ Present address: Veterinary Laboratory of the Meuse Département, Chemin des Romains, 55000 Bar-Le-Duc, France.

<http://dx.doi.org/10.1016/j.watres.2014.09.030>

0043-1354/© 2014 Elsevier Ltd. All rights reserved.

5. Occurrence of parabens in freshwater and sediments	6
6. Occurrence of parabens in other types of water	6
6.1. Drinking water	6
6.2. Swimming pool water	7
6.3. Brackish and marine water	7
7. Occurrence of parabens in biota	7
8. Discussion and conclusions	7
Uncited reference	8
Acknowledgments	8
Supplementary data	8
References	8

1. Introduction

Parabens are a class of compounds that have been used for nearly 100 years for their anti-microbial and anti-fungal properties. First used as preservatives in the mid-1920s for pharmaceutical products, paraben use was rapidly expanded to food and cosmetics (Andersen, 2008; Guo et al., 2010; Guo and Kannan, 2013; Soni et al., 2005). In cosmetics alone, parabens are found in more than 22,000 products with maximum content of 0.4% for each paraben species and 0.8% in combination (Andersen, 2008). In pharmaceutical products, maximum paraben content rarely exceeds 1% (Soni et al., 2005). Parabens are mainly active on Gram-positive bacteria, yeast and molds. They have little effect on bacterial spores, and none on viruses, mycobacteria and prions. They are thus frequently used in combination with other types of preservatives (Soni et al., 2005). Parabens are used as excipients in pharmaceuticals to avoid microbial contamination and prevent degradation of the active ingredient (Soni et al., 2005). Methylparaben (MeP) is also used as a plasticizer for pharmaceuticals, and facilitates certain stages in the production of medicines (Wu and McGinity, 2003). Recently, parabens have been detected in currency bills and paper products including sanitary wipes (Liao and Kannan, 2014).

Parabens are considered ideal preservatives because they have a wide spectrum of anti-microbial activity, are highly stable in regard to variation in pH, are relatively safe to use and have low production costs (Biedzka et al., 2014; Soni et al., 2005). However, a 2004 British study (Darbre et al., 2004) suggested a link between parabens and breast cancer. Previous studies have suggested that parabens play a role as endocrine disruptors (Oishi, 2002a, b; Routledge et al., 1998). Over the past few years, parabens have been frequently incriminated, although the results on the risks stemming from the use of these compounds are still inconclusive (Andersen, 2008; Biedzka et al., 2014; Soni et al., 2005).

The ubiquitous presence of parabens and their metabolic products in urine shows that humans are exposed to parabens via different routes (Moos et al., 2014; Shirai et al., 2013; Wang and Kannan, 2013; Wang and Kannan, 2013). Exposure via food, cosmetics, and pharmaceuticals has been studied and has given contrasting results according to the approach used and the study population (Cashman and Warshaw, 2005; Guo and Kannan, 2013; Guo et al., 2014; Liao et al., 2013a, 2013c;

Soni et al., 2005). Nevertheless, all studies point to cosmetics as the main source of exposure to parabens in humans (Biedzka et al., 2014; Soni et al., 2005).

The use of parabens as food additives is authorized in the European Union by Regulation (EC) No 1333/2008 of the European Parliament and of the Council of 16 December 2008 on food additives (EP, 2008). In cosmetics, the use of parabens is regulated by Directive 76/768/EEC (EP, 1976). MeP is one of the substances controlled by REACH regulations. The other parabens are at present only recorded on the REACH candidate list (DEPA, 2013). In contrast, there are currently no regulations regarding the presence of parabens in the environment or, in particular, in water or wastewater.

Parabens have been detected in the air, dust and in soils (Biedzka et al., 2014), but these aspects will not be addressed here. The first results demonstrating the presence of parabens in water were published in 1996 (Paxéus, 1996). However, it was only in the mid-2000s, with further development and generalization of liquid chromatography-tandem mass spectrometry (LC/MS MS) that data could actually be acquired on their distribution and presence in aquatic environments. This review compiles the main data on the presence and fate of parabens in water and in certain aquatic compartments (biota and sediments). The objective is to provide a current overview of paraben contamination and what is known on the behavior and fate of these compounds in water. The potential impacts of this contamination on aquatic organisms have been reviewed elsewhere (Brausch and Rand, 2011) and are not in the scope of this review.

2. Chemistry, production and discharges

Parabens or para-hydroxybenzoates are esters of para-hydroxybenzoic acid (*p*-HBA), hence the common name. All members of this class of compounds share the same chemical backbone with a benzene ring, a hydroxyl group and an ester group in the para position of the ring. Compounds differ in the length of the alkyl chain (Table 1).

Parabens can be classified into two categories: short-chain parabens, i.e. methylparaben (MeP) and ethylparaben (EtP), and long-chain parabens, i.e. propylparaben (PrP), isopropylparaben (i-PrP), butylparaben (BuP), isobutylparaben (i-BuP) and benzylparaben (BzP) (Soni et al., 2005).

Download English Version:

<https://daneshyari.com/en/article/6366252>

Download Persian Version:

<https://daneshyari.com/article/6366252>

[Daneshyari.com](https://daneshyari.com)