



Review

Perfluorooctane sulphonate (PFOS) throughout the food production chain

E.D. van Asselt^{a,*}, R.P.J.J. Rietra^b, P.F.A.M. Römken^b, H.J. van der Fels-Klerx^a^aRIKILT – Institute of Food Safety, Wageningen University and Research Centre, P.O. Box 230, 6700 AE Wageningen, The Netherlands^bALTEIRA, Wageningen University and Research Centre, P.O. Box 47, 6700 AA Wageningen, The Netherlands

ARTICLE INFO

Article history:

Received 17 September 2010

Accepted 7 March 2011

Available online 12 March 2011

Keywords:

Transfer

Soil

Crop

Water

Farm animals

ABSTRACT

Perfluorooctane sulphonate (PFOS) is a persistent organic pollutant with adverse effects on human health. Since dietary intake plays an important role in human exposure, the transfer of PFOS throughout the food chain needs further investigation. The aim of this paper is to give an overview of PFOS concentrations and transfer for the various chain steps from farm-to-fork. This reveals that most research focused on levels of PFOS in surface water and fish but data on soil and crops are largely missing. Furthermore, the uptake of PFOS by farm animals and subsequent transfer into meat and animal products needs further attention, as these products will eventually be consumed by the human population. Once the necessary data gaps are filled, the contribution of the various chain steps on the total PFOS intake can be established. Moreover, the effect of pollution events on the food chain can be established enabling appropriate actions in order to protect consumer health.

© 2011 Elsevier Ltd. All rights reserved.

Contents

1. Introduction	1
2. PFOS in water	2
3. PFOS in soil	3
4. PFOS in crops	3
5. PFOS in animals	3
6. PFOS in food	4
7. Conclusions	5
Acknowledgements	5
References	5

1. Introduction

Perfluorinated compounds (PFCs) are compounds in which all hydrogen atoms attached to carbon atoms are replaced with fluorine atoms. They are persistent chemicals that are widely distributed in the environment. Exposure to PFCs has resulted in hepatotoxicity, developmental toxicity, immunotoxicity, adverse hormonal effects and carcinogenic potency in animal studies (Clarke et al., 2010; Hölzer et al., 2008; Wilhelm, Kraft, Rauchfuss, & Hölzer, 2008). The group of PFCs includes perfluorooctane sulphonate (PFOS), which is the most frequently detected compound in food products with generally the highest concentrations within the PFC group (FSA, 2009). PFCs can be found in surface water,

sewage sludge, soil, sediment and air across the world, with elevated concentrations in relatively populated and industrialised regions, especially near production sites (Giesy & Kannan, 2001; Houde, Martin, Letcher, Solomon, & Muir, 2006; Lau et al., 2007; OECD, 2002). They can also be found in remote regions such as the Arctic (Dietz, Bossi, Rigét, Sonne, & Born, 2008; Giesy & Kannan, 2002). At the moment, there is a lack of information on the exact sources of PFCs in the environment. Contamination in wildlife varies among species and locations which indicates multiple emission sources. PFCs may be released into the environment by manufacturing or disposal operations or during the useful lifetime of a product (Houde et al., 2006). Several sources, such as discharge of industrial and municipal wastewater, fire-fighting operations at military bases and airports, and landfill leachate, may be responsible for elevated exposure to PFCs in urban areas (Houde et al., 2006; Vestergren & Cousins, 2009). In 2006, high concentrations of PFCs

* Corresponding author. Tel.: +31 317 480268; fax: +31 317 417717.

E-mail address: esther.vanasselt@wur.nl (E.D. van Asselt).

were detected in surface and drinking water in Germany (Skutlarek, Exner, & Farber, 2006). As a result of this, an extensive monitoring program was initiated analysing soil, surface and drinking water to identify sources of PFC exposure (LANUV, 2008). This monitoring program showed that the source of the PFC contamination in this case was the widespread use of soil conditioner, which had been mingled with industrial waste. This contamination has led to elevated PFC concentrations in the blood plasma of children and adults living in the area (Hölzer et al., 2008). A similar pollution event occurred in Alabama, resulting in increased PFOS concentrations in soil and sludge (EPA, 2009; Renner, 2009).

Aqueous fire fighting foams (AFFFs) presumably are the most prominent source of widespread environmental dispersal of PFOS. As a result of this, PFOS has increased in a range of wildlife over the period 1969–2002 (Paul, Jones, & Sweetman, 2009). The 3M company, the dominant global producer of PFOS responsible for the large majority of total global production volumes, phased out production in 2002. Since then, the first declines in human exposure have been reported (Brooke, Footitt, & Nwaogu, 2004; Clarke et al., 2010). In the EU, a restriction is laid down on the marketing and use of PFOS following directive 2006/122/EEC as an amendment of directive 76/769/EEC. This restriction covers all products to which PFOS is added intentionally (e.g. textiles). Moreover, the use of PFOS in the plating industry should be minimised and the use of existing stocks of fire-fighting foams containing PFOS is allowed until June 2011. On-going uses in the aviation industry (hydraulic fluids), the semiconductor industry and the photographic industry (coatings) are not supposed to pose a relevant risk to the environment or human health if releases into the environment and workplace exposure are minimised. Recently, the EU commission has recommended the monitoring of PFOS and PFOA in food (2010/161/EU). There is, however, currently no legislation for PFOS in food and feed within the EU. Their use in plastics and coatings for food contact materials has been approved in the Netherlands and Germany (EFSA, 2008). However, as soon as safer alternatives are feasible, the use of PFOS is phased out. Recently, PFOS has been designated as a Persistent Organic Pollutant under the Stockholm Convention (United Nations Environmental Programme, 2009). PFOS is also added to the OSPAR list, an international governmental cooperation for the protection of the Marine environment of the North-East Atlantic, list of Chemicals for Priority Action in 2003 (OSPAR, 2006).

PFOS emissions are estimated to continue over the next decade from stain-resistant carpets and from PFOS containing AFFFs until the latter is banned in Europe in 2011 (Halldorsson et al., 2008). Since PFOS has an estimated half-life of 41 years in the environment (Clarke et al., 2010), it is likely to be of continued public health interest. The route of human exposure to PFOS, however, has not been well characterised (Halldorsson et al., 2008). Although non-food sources such as house dust and outdoor air are seen as possible contamination routes, they contribute less than 2% of the average intake (EFSA, 2008). Dietary intake is, therefore, considered as an important source of exposure to PFOS

(Ericson, Martí-Cid, et al., 2008; Fromme, Tittlemier, Völkel, Wilhelm, & Twardella, 2009; Tittlemier et al., 2007; Trudel et al., 2008; Wilhelm et al., 2008). However, the contamination route from farm-to-fork is largely unknown (Fig. 1). It is, therefore, necessary to gain insight into the levels and transfer of PFOS for the various steps in the food supply chain. Once the transfer of PFOS through the food chain can be quantified, the relevance of the various chain steps for human intake can be established. The aim of this paper is, therefore, to give an overview of PFOS levels as published in literature for the various steps in the food supply chain together with information available on the transfer of PFOS from one step to the next.

2. PFOS in water

PFOS can enter the aquatic environment through manufacturing companies and other sources, which eventually may lead to polluted tap water (Suja, Pramanik, & Zain, 2009). Several review papers have published levels of PFOS in surface water (Chen et al., 2009; Ericson, Nadal, Van Bavel, Lindström, & Domingo, 2008; Fujii, Polprasert, Tanaka, Lien, & Qiu, 2007; Suja et al., 2009). The majority of surface water data originate in Japan and the USA. Although PFOS can be removed from drinking water with activated coal, this treatment is not common. Therefore, monitoring of surface water is relevant to evaluate possible contamination through drinking water (Nakayama, Strynar, Reiner, Delinsky, & Lindstrom, 2010). Direct tap water data are encountered less frequently. An overview of PFOS levels in surface and drinking water can be found in, EFSA (2008). Background levels in drinking water ranged from <0.01 to 50.9 ng/l (with median values between 1 and 5 ng/l) and in surface water from <0.01 to 135 ng/l (with median values around 1 ng/l) (EFSA, 2008). PFOS concentrations can be much higher close to a local contamination source. Point sources were, e.g. identified by Saito et al. (2004), who traced down high levels of PFOS in the Yodo river (up to 526 ng/l) to the Osaka international airport; presumably due to the use of AFFF. Another local source was established in Germany where contaminated soil conditioner was used leading to high PFOS levels in the Moehne river (up to 5900 ng/l) (Skutlarek et al., 2006). Wastewater treatment plants (WWTP) are also often linked to high local concentrations of PFOS (Nakayama et al., 2010). Despite the phasing out of PFOS production in 2002, products containing PFOS are still being used and released into WWTP (Loganathan, Sajwan, Sinclair, Senthil Kumar, & Kannan, 2007). The levels depend upon the fraction of industrial contribution to the WWTP (Becker, Gerstmann, & Frank, 2008; Sinclair & Kannan, 2006; Yu, Hu, Tanaka, & Fujii, 2009) with current maximum levels in the order of 100 µg/kg dry weight (3M, 2001a; Becker et al., 2008; Bossi, Strand, Sortkjær, & Larsen, 2008; Loganathan et al., 2007; Schultz et al., 2006; Senthilkumar, Ohi, Sajwan, Takasuga, & Kannan, 2007; Sinclair & Kannan, 2006; Yu et al., 2009). Mass flow studies in waste water treatment have shown an increase in PFOS from influent to effluent that may be due to biodegradation of precursor compounds during activated sludge treatment

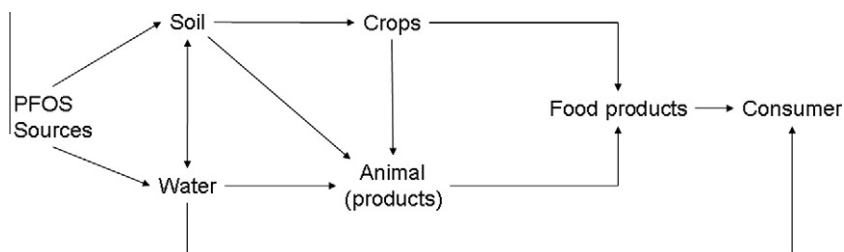


Fig. 1. PFOS transfer throughout the food chain.

Download English Version:

<https://daneshyari.com/en/article/10542172>

Download Persian Version:

<https://daneshyari.com/article/10542172>

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