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Loads of parabens, triclosan and triclocarban in greywater: are PCPs the main source of contamination?

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1. Introduction

The use of soaps, shampoos, toothpastes or other personal care products (PCPs) generates discharges of chemicals into the environment. These latter present ecotoxicological potentials (endocrine disruption, fertility reduction, and developmental abnormality). Moreover, chronic and/or possibly synergistic effects of numerous pharmaceuticals and other chemicals even at trace concentrations may also become an issue.

Among these chemicals, parabens (PBs), triclosan (TCS) and triclocarban (TCC) are widely used in the composition of PCPs but also in sportive clothes, plastic toys, kitchenware, pharmaceuticals and food products as antiseptic or conservative. Their utilization releases in greywater organic compounds which are potentially toxic. Only few researches have published about the occurrence of parabens and triclosan in greywater [1-2]. These previous works indicate that the concentrations can vary in greywater samples from below limit of quantification to few $\mu g.L^{-1}$ without any distinction between the different kinds of greywater (shower, washbasin, etc.). As a consequence, these chemicals are found in surface waters at $ng.L^{-1}$ level [3] because of a partial removal in wastewater treatment plant and urban discharges during wet weather.

In this context and for a better knowledge of the contribution of different types of greywater to the wastewater contamination, it was decided to analyse several kinds of greywater from shower, washbasin, manual dishwashing or washing machine. The awareness of the greywater contamination is needed for establishing a better management of the contamination at source. The objectives of this project are i) to assess the level of impregnation for these compounds for different kinds of greywater ii) to compare the different kinds of greywater in order to evaluate the main source; and iii) to evaluate the contribution of greywater to the wastewater contamination.

2. Materials and methods

Four types of greywater were sampled: manual dishwashing (GW1, n=5), washing machine (GW2, n=3), showers (GW3, n=16) and washbasin (GW4, n=5). The samples were collected by volunteers in glass bottles and maintained at low temperatures using icebox. Eight compounds were analyzed including six parabens: methylparaben (MeP), ethylparaben (EtP), propylparaben (PrP), benzylparaben (BzP), butylparaben (BuP), isobutylparaben (IsobuP), TCS and TCC. After filtration (GF/F 0.7 µm) and extraction, the dissolved fraction was analyzed by liquid chromatography coupled with tandem mass spectrometry (LC/MSMS) using MeP-d4 and TCC-d4 as internal standards.

3. Results and discussion

3.1. Concentrations in greywater

The dissolved concentrations measured in greywater for PBs and TCS are given in Figure 1. For MeP, EtP and PrP, the frequency of detection was 100 % and for TCS it was 67 %. Since BzP, BuP, IsoBuP and TCC were rarely quantified, therefore, it will not be discussed thereafter. Concerning the parabens, the calculated median concentrations were 0.4 $\mu g.L^{-1}$ for manual dishwashing, 9.6 $\mu g.L^{-1}$ for washing machine, 1.6 $\mu g.L^{-1}$ for shower and 33.9 $\mu g.L^{-1}$ for washbasin. In the case of TCS, calculated median concentrations were 2.3 $\mu g.L^{-1}$ for manual dishwashing, 2.6 $\mu g.L^{-1}$ for washing machine, 0.5 $\mu g.L^{-1}$ for shower, and 1.7 $\mu g.L^{-1}$ for washbasin. These concentrations were similar to those from previous studies which present concentrations of about few $\mu g.L^{-1}$ for the most concentrated compounds (MeP, EtP, PrP, and TCS) [1-2]. We highlighted that each greywater was significantly contaminated both by PBs and TCS.

For a given type of greywater, the variations of paraben concentrations were very high from sample to sample. On the contrary, the TCS concentrations appeared to be less variable. These significant variations

can be explained by the consumption patterns and the practices of each volunteer. In addition, the paraben profiles (ratio of the concentrations of a given congener to the sum of parabens) of the different types of greywater, given in Figure 2, were similar showing a predominance of MeP with respect to the profiles from literature [1,4].

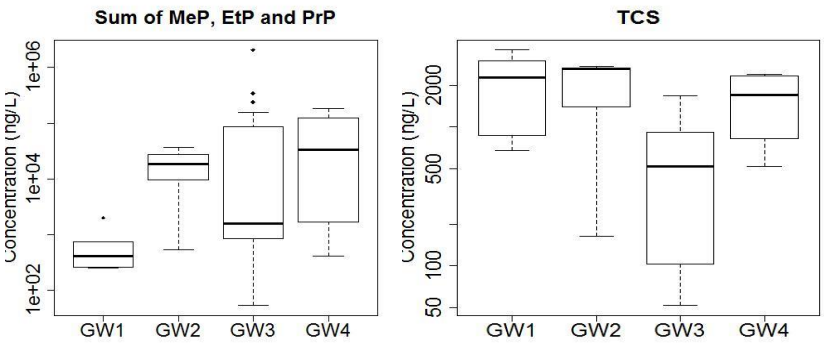

Figure 1: Parabens and triclosan dissolved concentrations in greywater.

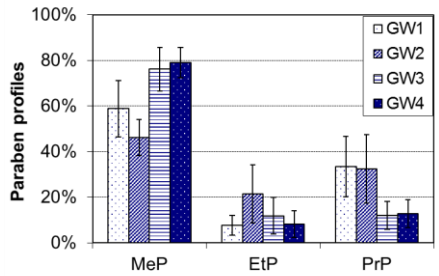

Figure 2: Paraben profiles.

3.2. Contribution of greywater to the loads in wastewater

Mass loads were calculated on the basis of both the median concentrations and the daily water consumption data in Paris (from www.sedif.com). The calculated loads in greywater were about 500 µg/inhabitant/day for MeP, 24 µg/inhabitant/day for EtP, 52 µg/inhabitant/day for PrP and 112 µg/inhabitant/day for TCS. Depending on the compounds, washbasin and washing machine were the main contributors to the contamination of wastewater. These loads were compared to those measured in wastewater in Paris conurbation [4]. Our calculated loads originated from 60% of the daily water consumption but they only accounted for 3 to 49 % of the pollutant loads. Three hypotheses may explain these results: (i) either the pollutants loads were reduced in wastewater since the last monitoring in 2010 following change in consumption practices; (ii) there are other sources of these molecules in wastewater than greywater; or (iii) using the median leads to an underestimation of the loads because the measured concentrations covered a wide range of several orders of magnitude (from 1 to 10^6 ng.L^{-1}).

4. Conclusions

The key lessons highlighted by this study are that greywater strongly contributes to the contamination of wastewater. However PCPs are not the only source of parabens and triclosan in wastewater: dishwashing and washing machine waters appeared as concentrated as shower water. Moreover measured concentrations were highly variable depending on the consumption practices. This latter finding indicates the need to link environmental sciences with social sciences; this is our outlook for a future research in the frame of the Cosmet'eau project. New samplings of wastewater will be carried out in 2015 to evaluate the evolution of concentrations in wastewater in relation to potential consumption changes (i.e. paraben free products or organic cosmetics).

5. References

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