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Source: Hopkins, Z. and Blaney, L. (2016). An aggregate analysis of personal care products in the environment: Identifying the distribution of environmentally-relevant concentrations. *Environment International*, 92-93: 301-316. DOI: 10.1016/j.envint.2016.04.026.

Contact:
blaney@umbc.edu

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1. Analyses were conducted using aggregate concentrations from a variety of treatment systems.

European Commission

Science for Environment Policy

Aquatic life needs further protection from effects of personal care products

Personal care products (PCPs) are a diverse group of products, including toothpaste, shampoo, make-up and soaps. The number and use of these products has increased over recent decades, generating concern about their impact on the environment. This literature review analysed over 5 000 reports of environmental detection of 95 different chemicals from PCPs. The analysis reveals toxic levels of PCP chemicals in raw and treated wastewater, and in surface water. The researchers recommend treatment methods focusing on antimicrobials, UV filters and fragrance molecules.

In order to fulfil a broad range of functions, PCPs contain a wide range of chemicals, from filters that block out UV light to antibiotics and insect repellents. PCPs are generally washed off the skin and, as a result, chemicals from PCPs have been found in raw and treated wastewater, surface and ground water, and even drinking water.

There are potential human health implications from ingesting these chemicals by way of drinking water or seafood. In addition, the entry of PCPs into surface waters could be toxic for aquatic organisms. Some PCP chemicals that repel water are particularly difficult to remove during wastewater treatment (which aims to protect the environment from the adverse effects of pollution) and can accumulate up the food chain. Wastewater solids (sludge) and effluent are in some cases applied to land to improve soil and for irrigation purposes, respectively, creating a risk that these compounds will indirectly enter nearby water bodies, or food crops. Early findings suggest wastewater treatment processes do not always ensure a safe concentration of PCP chemicals.

This review combined recent findings to build a picture of the concentrations of chemicals from PCPs found in the environment. The researchers collected over 5 000 environmental detections of PCPs from around the world, including several European countries. The concentrations of the 95 detected chemicals were added to a database. Most environmental detections (2 290) were in surface water, followed by 1 240 detections in wastewater effluent, 879 in wastewater solids, and 873 in raw wastewater. By comparing the data on occurrence with toxicity data, also from previously published studies, they found that some levels measured in raw wastewater, wastewater effluent and surface water could be toxic to aquatic life.

The results also emphasise just how ubiquitous these chemicals are in the aquatic environment. Many chemicals were detected in the wastewater of several countries, such as the fragrance compound tonalide; nonylphenol (used to manufacture antioxidants, detergents and emulsifiers); the UV filter benzophenone-3 (used in sunscreen); and the anti-microbial agent triclosan. The highest reported concentrations were in North America and Europe, likely because per-capita consumption is higher in these areas.

The literature review showed that, after treatment[1], concentrations of chemicals from PCPs in wastewater can be reduced by between 33% and 90%. The UV filter octinoxate showed the highest average removal efficiency by wastewater treatment, while nonylphenol showed the lowest. In some cases, chemicals in treated wastewater remain above a level which has been shown to have harmful effects on aquatic organisms (such as the fragrance compound galaxolide, detected above a level of 0.1 micrograms per litre, and anti-bacterial triclosan, which has been detected above toxicologically-relevant concentrations of 0.65 micrograms per litre). However, it is important to note that aquatic organisms are not exposed directly to the levels in treated wastewater, which is diluted (although not always by a large factor) when it enters the receiving water body, such as a river.

Continued on next page.

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Aquatic life needs further protection from effects of personal care products *(continued)*

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In addition to being diluted, chemicals from PCPs can be broken down in the water body, although some are more resistant to natural attenuation than others. For example, galaxolide, nonylphenol and the UV filters sulisobenzone and 4MBC are generally removed well, while others are more resistant, such as octinoxate, the insecticide N,N-diethyl-3-methylbenzamide (DEET) and paraben preservatives. On average, concentrations in surface water were around half those in wastewater effluent.

Chemicals from PCPs have been detected in the environment for at least 30 years, and as PCP consumption and production increases, the implications for the environment will become even greater. As such, the researchers make three recommendations for the future:

1) **Continued monitoring**. Monitoring should be conducted for compounds that have known toxic effects on organisms at environmentally relevant concentrations. They recommend that *UV filters*, *polycyclic musks* (a type of fragrance chemical; these include tonalide and galaxolide) and *triclosan* be considered priorities.

2) **Expand analysis to new compounds**. Only a small proportion of the hundreds of PCP chemicals have been monitored in the environment so far. It is important to expand analysis to new compounds. Understanding the environmental distribution and concentrations of all chemicals from PCPs — as well as their derivatives — will allow toxicity analysis to be made more relevant, and enable evidence-based decision-making.

3) **Developing effective treatment processes**. There is a need for more effective methods of treating water to remove/de-toxify chemicals from PCPs, particularly those of highest concern, to prevent negative impacts on aquatic species and on people.

It should be noted that the full removal of PCP chemicals by urban wastewater treatment plants is difficult, expensive and has environmental impacts (e.g. use of energy and chemicals, contaminated sludge disposal). It is an EU principle that a preventive approach should be taken in relation to environmental damage, with the aim of tackling it at source[2], for example by not authorising chemicals that could be harmful, or by restricting use. Legislation is in place to prompt or require consideration of alternative chemicals should those present in products on the market be identified as posing a risk to the environment or human health.

The issues identified by this study could be included in the EU's strategy for a non-toxic environment, likely to be presented in 2018.

2. See Article 191 paragraph 2 of the Treaty of Lisbon amending the Treaty on European Union and the Treaty establishing the European Community, signed at Lisbon, 13 December 2007