Analytical tools for target and non-target screening of ubiquitous environmental pollutants in textiles and laundry wastewater

Abstract

Production of textiles is a long multistep-chain, involving numerous hazardous chemicals. It is estimated that more than 3,500 chemicals are currently used worldwide within textile production and approximately 2,000 of these have not yet been registered in REACH. However, there are only very few studies so far on chemicals in textiles, despite being a source both to daily human exposure and pollution of the aqueous environment. Clothing textiles might be one of the most common and largest sources of harmful chemical exposure among the general population since they are worn close to the body repeatedly. The human skin is considered as our largest tissue with an area of approximately $2m^2$ exposed to the environment. Diffusive transport over the epidermal barrier can be achieved for compounds with a molecular weight < 1000Da and a log K_{OW} between 0.7 and 5.9, which can result in systemic exposure.

The fact that some substances in textiles are transferred from the fiber and penetrated through the skin, have been shown previously by our research group (Iadaresta et al. 2018). Hitherto, the data on human exposure to many compounds and its related toxicological effects are scarce. Furthermore, the content of hazardous chemicals in recycled textiles have, to the best of our knowledge, not or to a very little extent been performed.

Analytical methods are necessary for screening and quantification purposes to facilitate the evaluation of risk assessments related to the subsequent production of less hazardous materials. Thus, the major aim of this project is to develop and apply screening methodologies for both target and non-target/suspect screening of chemicals in textiles and laundry effluents. The samples will consist of a wide variety of materials, e.g. newly produced and recycled textiles, as well as wastewater occurring from laundry of textiles.

The research group by Prof. C. Östman have emphasized the presence of several hundreds of chemicals in textile articles of which several have shown adverse effects within natural biota [Luongo 2014, Luongo 2015a, Luongo 2015b, Luongo 2015c, Luongo 2016, Avagyan 2013, Avagyan 2014]. An ongoing project has identified textile chemicals with biological effects in sewage water from Swedish WWTPs. Suspect- and non-target screening methodologies are evaluated using data processing software, e.g MS dial, Compound Discoverer etc. More specifically, an interest regarding the context of a fast screening methods that could be implemented by the textile industry is thermal desorption of textiles followed by GC-MS analysis. Experimentally, it has been shown that chemicals could remain for a long time in the clothing even after several laundry cycles, resulting in a skin permeation. Chemicals that are removed through laundry are further transferred into the sewage water, and some substances may remain after the treatment process, resulting in a release to the environment, which may disturb the fertility of aquatic organisms.

Based on the current societal status, methods for identifying regulated and non-regulated chemicals will be developed. In just a few years, a new legislation will be applied, meaning that textile manufacturers are obliged to pay an additional tax assuming that they fail to prove that the fibres are free from hazardous substances. In the long run, our research will facilitate future guidelines and regulations regarding chemicals that are found in textiles, which will enable a sustainable circular economy for essentially all humans that wear clothes.

Specific goals

- Screening and quantification of azo dyes and their cleavage products originating from textile articles purchased on the retail market in Stockholm.
- To screen, identify and quantify textile chemicals in laundry waste water, using liquid chromatography tandem mass spectrometry
- To develop a non-target screening methodology of textile pollutants in sewage water by LC-MS/MS.