IWA abstract: Fate of micropollutants during wastewater treatment

Short summary: The wastewater from eight different wastewater treatment plants in Denmark were screened for 287 micropollutants of which 79 were detected and quantified. This comprehensive screening was used to determine the removal efficiency within wastewater treatment plants, and the influence of catchment area on the chemical composition of wastewater. Finally, the quantified micropollutants were compared to Predicted No Effect Concentrations in the environment to identify micropollutants of concern.

Abstract

A large number of chemicals has been produced and are continually being introduced to the market. This includes but are not limited to: pharmaceuticals, pesticides, food conservative, personal care products and industrial precursor chemicals. A large number of micropollutants has been found in wastewater [1] were they potentially can possess toxic risks for the environment and for human health [2]. Insufficient removal and generation of transformation products in the WWTPs can result in micropollutants beeing released to the environment [1,2].

This study has aimed at investigating the fate of micropollutants during wastewater treatment and the influence of the catchement area on the chemical profile of pollutants entering the WWTP. The study combine analysis of influent and effluent with environmental risk assesment by comparison of quantified concentrations with Predicted No Effect Concentrations.

A comprehensive target analytical workflow combining two of the most advanced analytical techniques was developed; LC-QToF and GCxGC-QToF. The combination of techniques allowed for a comprehensive screening that covered micropollutants of a wide range of polarities and chemical properties. Overall, 287 micropollutants were included in this screening.

A total of 79 micropollutants were identified and quantified in the wastewater. These micropollutants covered a broad range of chemicals from different sources including pharmaceuticals, food additives, industrial chemicals, pesticides and chemicals of other uses.

Removal efficiencies of individual micropollutants during wastewater treatment was quantified by comparing influent with effluent wastewater concentrations (Figure 1). The study found six micropollutants with removal efficiency between 0-10 %, 12 micropollutants with removal efficiencies between 20-70 % and nine micropollutants with removal efficiencies above 70 %. Seven of the studied micropollutants was found in higher concentrations in effluent compared to influent water streams.

Overall, it was found that the removal efficiencies of the micropollutants in question were specific for the individual compound and not dependable on the individual WWTPs.

The study demonstrated that the chemical profile of micropollutants were highly specific for the catchment area for the individual WWTP. Pesticides were mainly found in rural areas whereas pharmaceuticals could be linked to the composition of the human population in the catchment area. Some of the micropollutants were found to correlate with rain events.

The environmental risk of each micropollutant was evaluated by comparing with the Predicted No Effect Concentration calculated from EC50 and LC50 of Dapnia and Algea, respectively. Four micropollutants were identified as major potential environmental risks, as the concentrations of these in effluent wastewater were found to be above the calculated Predicted No Effect

Concentration. This include two antibiotics (Clindamyzin and Erythromycin) and the two pesticides (Metribuzin and Terbutryn).

This study demonstrates the importance of including the catchment area in risk evaluation of the potential releases of micro pollutants from a WWTP.

Conclusions derived from this study:

- 79 individual micropollutants identified and quantified in wastewater from 8 Danish WWTPs.
- Very significant differences in the removal efficiency of individual micropollutants during wastewater treatment.
- High influence of the catchment area on the chemical profile of micropollutants in influent water streams.
- Four micropollutants have been found in effluents in concentrations above their expected Predicted No Effect Concentrations.

Bibliography

[1] P. Gago-Ferrero, A. A. Bletsou, D. E. Damalas, R. Aalizadeh, N. A. Alygizakis, H. P. Singer, J. Hollender and N. S. Thomaidis, "Wide-scope target screening of>2000 emerging contaminants in wastewater samples with UPLC-Q-ToF-HRMS/MS and smart evaluation of its performance through the validation of 195 selected representative analytes," *Journal of Hazardous Matrials,* pp. 1-14, 2020.

[2] A. Gosset, L. Wiest, A. Fildier, C. Libert, B. Giroud, M. Hammada, M. Hervé, E. Sibeud, E. Vulliet, P. Polomé and Y. Perrodin, "Ecotoxicological risk assessment of contaminants of emerging concern identified by “suspect screening” from urban wastewater treatment plant effluents at a territorial scale," *Science of the Total Environment,* 2021.

Figures/Tables

Wastewater treatment plants:

Table 1: The eight WWTPs included in this study. For each WWTP the treatment steps are presented together with the capacity of the WWTP (PE).

Treatment plant	Treatment steps							Capacity (PE)
	Mechanical filtration	Biological treatment	Oxidation Ammonium to nitrate	Denitrification	Chemical treatment	Sand filter filtration	Large water reservoir	
WWTP A	X	X	X	X	X			750,000
WWTP B	X	X	X	X	X			400,000
WWTP C	X	X	X	X	X			350,000
WWTP D	X	X	X	X	X	X		385,000
WWTP E	X	X	X	X	X	X		48,300
WWTP F	X	X	X	X	X	X		30,000
WWTP G	X	X	X	X	X		X	20,000
WWTP H	X	X	X	X	X		X	12,500

Removal efficiency

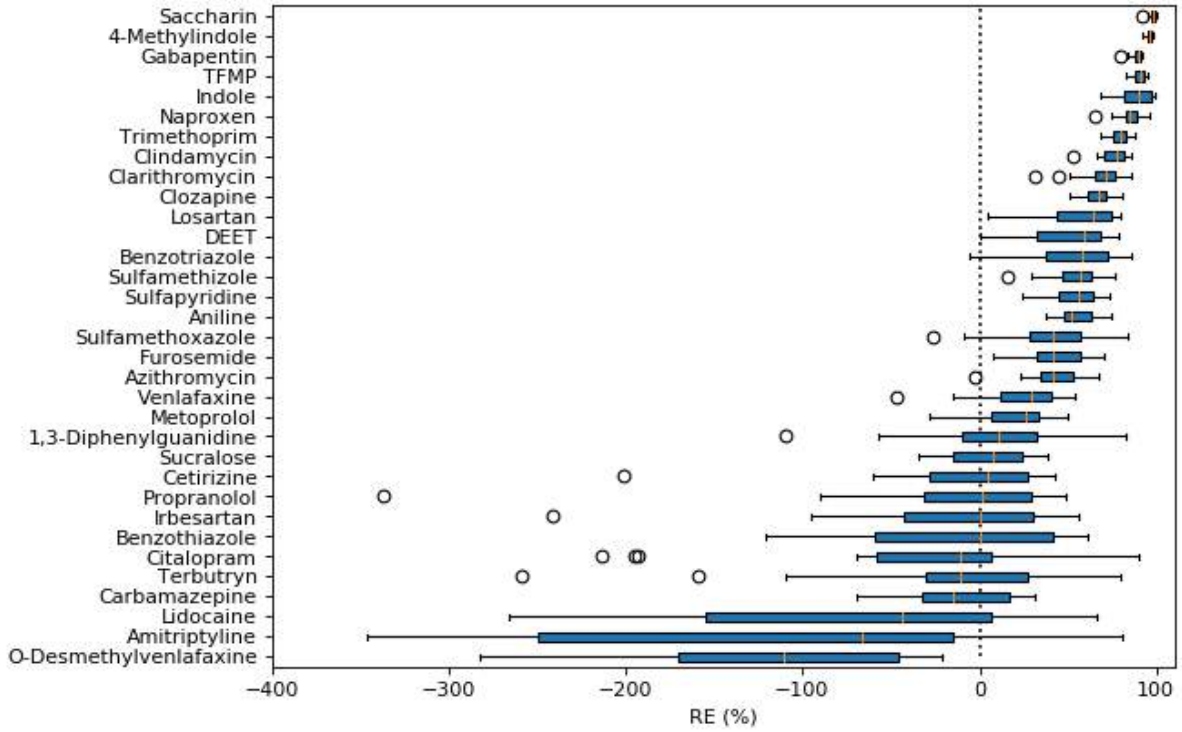

Figure 1: Removal efficiencies (RE) of selected micro pollutants. A positive removal efficiency indicate removal of the particular micropollutant during treatment 0 % removal efficiency indicate that the concentration is similar in influent and effluent wastewater. A negative removal efficiency indicate that the concentration is higher in effluent compared to influent.