Occurrence, alteration and reduction of ecotoxicological effects of hospital wastewater from different advanced treatment

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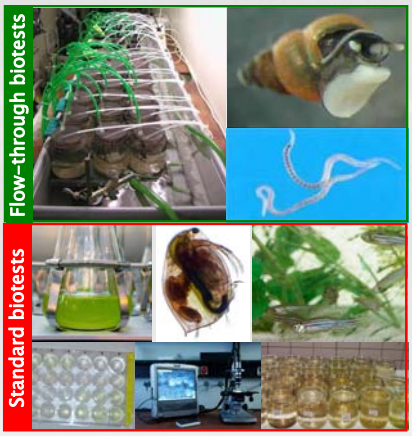
Introduction

A multitude of micropollutants has become ubiquitously detectable in the aquatic environment, but the ecotoxicological effects of these complex mixtures on the populations and the communities in the aquatic environment are mostly unknown.
In the PILLS project investigating the Pharmaceutical Input and Elimination from Local Sources (funded by the European Union through INTERREG IVB, for details see www.pills-project.eu) the effluent quality of different treatment steps in a full-scale hospital wastewater treatment plant (HWWTP) was assessed with respect to the ecotoxicological effects and the occurrence of 72 micropollutants (mainly pharmaceuticals). The HWWTP consisted of sequential and parallel combinations of the advanced treatment steps membrane bioreactor (MBR), ozonation, powdered activated carbon adsorption and sand-filtration.
The applied ecotoxicological test battery included two on-site (flow-through) and three off-site acute and chronic in vivo tests and, additionally, one in vitro test. The test battery is characterized by different trophic levels, by acute and chronic toxicity tests as well as different toxicological endpoints.
Here the results of the bioassays investigating different treatment steps will be presented.



Materials and Methods

Wastewater treatment plants

The full-scale hospital wastewater treatment plant (HWWTP) at the Marienhospital in Gelsenkirchen consisted of sequential and parallel combinations of the advanced treatment steps membrane bioreactor (MBR), ozonation (O), powdered activated carbon adsorption (AC) and sand-filtration (OS).

In vivo biotest battery

The applied in vivo test battery includes two on-site (flow-through) and four off-site acute and chronic tests with representatives of different trophic levels.

Flow-through biotests (28 days)

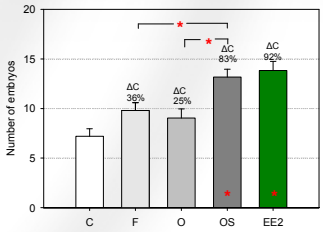
- Snail *Potamopyrgus antipodarum* – number of embryos
- Blackworm *Lumbriculus variegatus* – biomass

Static and semistatic standard biotests

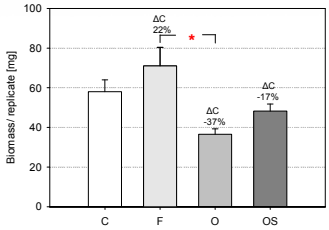
- Green algae *Desmodesmus subspicatus* – growth rate after 72h
- Water flea *Daphnia magna* – acute – immobilisation after 48h
  chronic – population abundance after 21 days
- Zebrafish *Danio rerio* – Fish embryo test – mortality after 48h

Results

1 Freshwater snail *Potamopyrgus antipodarum*



2 Blackworm *Lumbriculus variegatus*



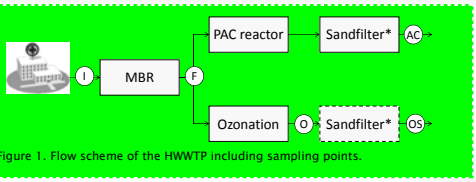
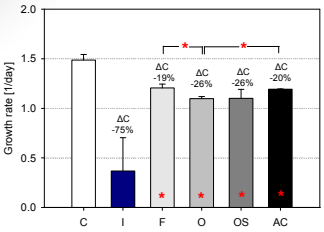


Figure 1. Flow scheme of the HWWTP including sampling points.

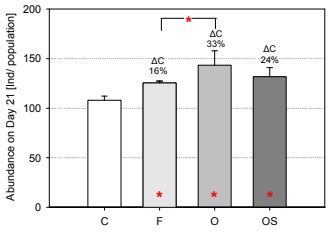
Legend

C – Control
F – filtrate of the membrane bioreactor
O – effluent after ozonation treatment
OS – effluent after ozonation and sandfiltration
AC – effluent after activated carbon and sandfiltration

3 Green algae *Desmodesmus subspicatus*



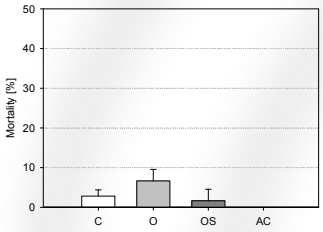
4 Water flea *Daphnia magna*



Portion [%] of adult daphnids (> 2.6 mm) in the populations treated with wastewater. * Significant (p<0.05) differences to the control population

Day	Control	F	O	OS
8	53.9	51.8	37.6*	40.3*
11	45.5	39.6	28.6*	33.6
12	41.9	37.1	23.8*	31.3
15	40.2	36.3	25.5*	30.6
18	41.7	34.3	34	37.4
20	43	38.5	32.5	40.7
21	43.9	37	33.9	37.2

5 Zebrafish *Danio rerio*



Conclusions

A By MBR treatment the growth inhibition of the green algae *Desmodesmus subspicatus* was significantly reduced, but the MBR effluent was still toxic to *D. subspicatus* and the snail *Potamopyrgus antipodarum* and slightly enhanced the reproduction of the snails.

B Four bioassays (*P. antipodarum* reproduction test, *L. variegatus* toxicity test, *D. subspicatus* growth inhibition test and *D. magna* population test) evidently showed an increased toxicity after the ozonation of the MBR effluent.These are strong indicators of adverse effects induced by transformation products.

C The subsequent post-treatment showed only minor reduction in contrast to prior published data for the ozonation of secondary effluent from municipal wastewater treatment plants.

Acknowledgement
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