



## Mixture toxicity of pharmaceuticals present in wastewater to aquatic organisms

Katarzyna Affek\*, Monika Załęska-Radziwiłł, Nina Doskocz, Kaja Dębek

Department of Biology, Faculty of Building Services, Hydro and Environmental Engineering, Warsaw University of Technology, Nowowiejska 20, 00-653 Warsaw, Poland, Tels. +48 22 2347903, +48 22 6212979; emails: katarzyna.affek@pw.edu.pl (K. Affek), monika.radziwill@pw.edu.pl (M. Załęska-Radziwiłł), nina.doskocz@pw.edu.pl (N. Doskocz), kajadebek@gmail.com (K. Dębek)

Received 13 December 2017; Accepted 21 January 2018

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### ABSTRACT

The aim of this study is the assessment of the impact of mixture of three pharmaceutical substances (ciprofloxacin, 17 $\alpha$ -ethinylestradiol and 5-fluorouracil) on aquatic animals, cyanobacteria and plants. Based on previous work and literature data, three concentrations of each substance were used to prepare mixtures: predicted or measured environmental concentrations (PEC/MEC), predicted no effect concentrations (PNEC), concentrations that induced a response of 10% in bioindicators (EC<sub>10</sub>). Immobilization tests with crustaceans (*Daphnia magna* and *Artemia salina*), growth tests with cyanobacteria (*Cyanosarcina* sp.), algae (*Desmodesmus quadricauda*, *Raphidocelis subcapitata*) and plants (*Lemna minor*), enzymatic test Fluotox and reproduction test with *D. magna* were performed. The results of this work confirm the importance of low concentration mixture exposure. Effect in PEC/MEC concentrations of the mixture of tested compounds was equal 15% in *R. subcapitata* growth test. As expected, effects obtained for mixtures of pharmaceuticals in their EC<sub>10</sub> concentrations were frequently higher than 10%. The obtained results were compared with the concept of independent action, which either underestimated or overestimated the effects in concentrations used. The results obtained in this study suggest that the exposure to tested mixtures of pharmaceuticals even in low concentrations of components, that individually cause no harm to organisms, may trigger adverse effects in aquatic environment.

*Keywords:* Mixture ecotoxicity; Pharmaceuticals; Ciprofloxacin; 17 $\alpha$ -Ethinylestradiol; 5-Fluorouracil

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\* Corresponding author.

Presented at the 13th Conference on Microcontaminants in Human Environment, 4–6 December 2017, Czestochowa, Poland.

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