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Professor Damia Barcelo was born in Lleida, Spain, in 1954. He received his Ph.D. in Analytical Chemistry in 1984. Since 1999, he has been a full Research Professor at the Institute of Environmental Assessment and Water Studies IDAEA-CSIC and the Head of the Environmental Chemistry Department (Barcelona, ES). Since May 2008, he has served as the Director of the Catalan Institute of Water Research (ICRA) (Girona, ES). He has published more than 512 scientific papers in scientific journals and has a Hirsch Index of 60. He is the editor of 13 books on environmental analysis and a co-author of a pesticide book. Other relevant activities include the following: networking experience at the EU (1997-2002); coordinator of the Waste Water Cluster (2002-2004), EMCO (2004-2007) and INNOVA MED (2007-2009) and partner of projects related with water and soil quality at the European Union Level. He has been supervising 24 Ph.D. theses on environmental analysis (1992-2008). In November 2007, he received the Spanish Prize King Jaime I on the Protection of the Nature.

Dr. Barcelo's scientific focus is on method development and monitoring of priority, new and emerging pollutants, including endocrine disrupting compounds, using advanced mass spectrometric analysis such as LC-MS/MS and hybrid instruments like LC-Q-TOF-MS and LC-MS-MS-LIT combined with bioassays, biosensors and endocrine effect studies.

ABSTRACT

“Fate and Behavior of Pharmaceuticals in Treated Wastewaters, Sludge and River Waters Followed by an Environmental Risk Assessment Using Hazard Indexes”

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Pharmaceuticals in their native form or as metabolites are continuously introduced to sewage waters mainly through excreta, disposal of unused or expired drugs or directly from pharmaceutical discharges. During the treatment at wastewater treatment plants (WWTP) they are either partially retained in the sludge, or metabolized to a more hydrophilic, but still

persistent form that passes the WWTP and ends up in the receiving waters. The removal of pharmaceuticals in WWTPs is variable and depending on the properties of the substance and process parameters (i.e. sludge retention time (SRT), hydraulic retention time (HRT), temperature). A large number of pharmaceuticals is hardly eliminated and therefore detected in WWTP effluents. Although present in low environmental concentrations, drugs can have adverse effects on aquatic organisms. These effects are rather chronic than acute toxic effects, depending on the exposure factor (bioavailability), degradability and susceptibility of the compound in question.

In this study a behavior of several pharmaceuticals belonging to different therapeutic categories (analgesics and anti-inflammatory drugs, lipid regulators, antibiotics, etc.) was monitored during treatment of wastewater in a pilot-plant membrane bioreactor (MBR). The elimination in MBR was compared with the elimination in a conventional activated sludge (CAS) process in an existing wastewater treatment facility. Performance of two MBR (one with flat sheet membranes and another with hollow fiber membranes) was monitored and from the measured concentrations of pharmaceuticals in the collected sludge samples and their corresponding supernatants, sorption capacities of primary, secondary activated and MBR sludge were estimated. Finally, total aqueous and solid phase output loads of WWTP were determined.

Furthermore, in order to gain better insight into the biodegradability and metabolic pathways of selected pharmaceuticals (diclofenac, aceclofenac, atenolol and glibenclamide) batch experiments were performed under controlled laboratory settings. For trace analysis of pharmaceuticals a quantitative methodology was developed based on solid phase extraction (SPE) and followed by LC-MS-MS on a hybrid quadrupole-linear ion trap (QqLIT) instrument. Samples were also screened for the presence of stable intermediates and these were characterized by QqLIT-MS and hybrid quadrupole time-of-flight (QqToF-MS).

Finally, a case study will be reported reporting a comprehensive monitoring program conducted to evaluate the input of pharmaceuticals and drugs of abuse through urban wastewater. Influent and effluent wastewaters of seven municipal WWTP from Ebro river basin (North-East of Spain) as well as river waters receiving effluent discharges were analyzed to assess the occurrence of 73 pharmaceuticals covering several medicinal classes. In a long term study covering four sampling campaigns, analgesics and anti-inflammatories altogether with anti-hypertensives were the most ubiquitous substances detected also at higher average concentrations from 1 up to 20 $\mu\text{g/L}$ in influents and from 0.4 to 1 $\mu\text{g/L}$ in effluents, respectively. Calculation of removal rates and half-lives revealed that an important number of target compounds were only partially removed with current treatments applied in WWTP, while some compounds such as carbamazepine, benzodiazepines, serotonin reuptake inhibitors and macrolide antibiotics presented poor or no elimination. In receiving river waters, due to an important dilution, levels detected were in the low ng/L range. However, the evaluation of hazard quotients, which are calculated by dividing measured environmental concentrations (MEC) by predicted no effect concentrations (PNEC), indicates that for few compounds the margin of safety is narrow.

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