REMOVAL OF EMERGING MICROPOLLUTANTS FROM WATER USING CYCLODEXTRIN

Zs M Nagy[1], K Gruiz[1], M Molnár[1], I Fekete-Kertész[1], É Fenyvesi[2], I Perlné Molnár[3]

[1]Department of Applied Biotechnology and Food Science, Budapest University of Technology and Economics, Budapest, Hungary (nagyzsumag@gmail.com)
[2]CycloLab Cyclodextrin R&D Laboratory Ltd., Budapest, Hungary
[3]Cooperative Research Center for Environmental Sciences, Eötvös Loránd University, Budapest, Hungary

There has been recently growing concern about emerging pollutants detected in waste waters, treated waste waters, surface and subsurface waters because of their biological activities adversely impacting human health and the environment. These emerging substances found in our environment are suspected of having secondary adverse effects, such as endocrine disrupting, immune-disrupting, sensitizing, allergizing effects.
As part of the risk management of emerging pollutants (see the AquaConSoil presentation of Molnár et al.) our research group developed and studied the implementation of cost-effective water treatment technologies in addition to the currently used conventional waste water treatment and drinking water pre-treatment technologies, for a more complete elimination of biologically active micropollutants, such as pharmaceuticals, cosmetic additives and industrial chemicals.
Cyclodextrins (CDs) which are traditionally used in pharmaceuticals and personal care products can form stabile complexes with the majority of organic micropollutants. Based on our former research results sorbents modified by CDs are able to extract hazardous substances selectively from contaminated water.
The main objective of our research was to develop new cyclodextrin-containing sorbents, suitable for the removal of micropollutants from drinking water and purified waste water.
Small scale laboratory experiments for pollutants removal were performed by application of ß-cyclodextrin bead polymer (BCDP) using model solutions spiked with emerging micropollutants such as ibuprofen, naproxen, ketoprofen, bisphenol-A, diclofenac, β-estradiol, ethinylestradiol, estriol, cholesterol at 5 µg/L level in flow-through systems.
The untreated model solution and the filtrate (treated water) were characterized by integrated methodology including GC-MS-MS for chemical analysis and various environmental toxicity tests by aquatic testorganisms such as *Lemna minor* duckweed, *Daphnia magna* water flea and *Heterocypris incongruens* crustacea.
The efficiency of the CD-based filters in post-purification of drinking water for selected compounds was highly superior compared to the commercial filters and activated carbon. Both the chemical analytical and toxicity results showed efficient elimination of the vast of pollutants. The measured significant decrease in the toxicity of the filtrate is due to the high binding capacity of BCDP without any release of organic matter (contrary to commercial filters and activated carbon).
Post-purification of waste water was modeled in scaled-up laboratory experiments applying ß-cyclodextrin bead polymer. The BCDP removed most of the micropollutants efficiently, especially bisphenol-A and hormones (β-estradiol, ethinylestradiol and estriol) from spiked model solutions.
Both lab-scale application of ß-cyclodextrin polymer (post-purification of tap-water in households and of purified waste water) have demonstrated outstanding removal capabilities for emerging contaminants. A BCDP containing unit after mechanical, biological treatment and ultrafiltration steps of waste water can be effective in risk reduction of emerging contaminants especially for the treatment of waste water at the sources (e.g. the effluents of hospitals) avoiding dilution due to mixing with the communal sewage and in green and blue technologies, such as ecobuildings or zero-emission houses.

ACKNOWLEDGEMENT
The financial supports of the National Innovation Office (TECH_08-A4/2-2008-0161, CDFILTER project and TECH_09-A4-2009-0129, SOILUTIL project) and the New Hungary Development Plan (TÁMOP-4.2.1/B-09/1/KMR-2010-0002) are greatly acknowledged.