Pilot-scale study on the removal of pharmaceuticals by LECA based SSF-constructed wetlands

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In recent years, the occurrence and fate of pharmaceutically active compounds (PhACs) in the aquatic environment has been recognized as one of the emerging issues in environmental chemistry. Some compounds are just resistant to degradation in the sewage treatment plants (STPs) while others, although suffering partial degradation, still end up in receiving water bodies due to the large inputs received in STPs [1]. Clofibric acid (a metabolite from a series of widely used blood lipids lowering agents), ibuprofen (an anti-inflamatory non-prescription drug) and carbamazepine (an anticonvulsant and mood stabilizing drug) are some of the most frequently found PhACs in environmental monitoring studies [1]. Wastewater treatment by sub-surface flow constructed wetland systems (SSF-CWs) is a low-cost technology that has shown some capacity for removal of several organic xenobiotic pollutants, but fewer studies exist on pharmaceuticals behavior.

The aim of the present work was to evaluate the efficiency of a pilot SSF-CW assembled with the plants cattail (*Typha spp.*) and a clay material (LECA 2/4) as support matrix, for the removal of three pharmaceuticals, namely ibuprofen (IB), carbamazepine (CB) and clofibric acid (CA), from contaminated wastewaters.

Four beds were planted with pre-grown cattails (density of 80 plants/m^2) and four were left unplanted to be used as controls. Experiments were conducted both in batch and in continuous mode with a flooding rate of 100%. Pharmaceutical concentrations were quantified by HPLC with UV detection at 210 nm (CB), 222 nm (IB) and 230 nm (CA). Solid phase extraction was used for sample pre-concentration whenever the measured pharmaceutical concentrations fell under the limit of quantification of the analytical method. The physico-chemical characterization of the support matrix material, LECA, involved the determination of properties such as pH, point of zero charge, electrical conductivity, apparent porosity, bulk density and hydraulic conductivity. In order to shed some light on the tolerance mechanisms developed by *Typha* spp. in the presence of these pharmaceuticals, biochemical and physiological parameters were evaluated.

Typha spp. showed good tolerance to the presence of CA, CB and IB concentrations of 1 mg L^{-1}, which is a value much higher than those usually reported in wastewaters. LECA alone was able to remove about 90% of the initial amounts of CB and IB in solution, and 50% of CA. IB was very susceptible to microbial degradation and up to 80% of the initial concentration could be removed by the microbial population present in the wastewater used.

Overall, the CWS shows a higher removal performance for CA, CB and IB than any of its individual components (plants, support matrix, microorganisms) considered separately. CA proved to be the most resilient compound, which comes in agreement with other published data. However, this system enabled the removal of substantially higher amounts of CA than has previously been reported in other studies.

The use of systems of this kind for the removal of pharmaceuticals from wastewaters seems like a promising alternative to the less efficient processes of conventional wastewater treatment.

REFERENCES

[1] Fent, K., Weston, A.N., Caminada, D. (2006) Ecotoxicology of human pharmaceuticals. *Aquatic Toxic*. 76 (2)**:**122-159.