USING CLAY MATERIALS TO REMOVE PHARMACEUTICALS FROM WATERS

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Pharmaceutical active compounds (PhACs) have an important role in the treatment and prevention of disease in both human and animals. Ingested drugs are only partially absorbed by the organisms and studies have shown that the excreted compounds are only partially removed in the sewage treatment plants (STPs) [1]. Contaminated effluents are being released from the STPs and trace amounts of PhACs have been detected in wastewaters, surface and groundwaters worldwide [1]. Acidic pharmaceuticals like diclofenac, ibuprofen and clofibric acid are some of the most frequently detected compounds [1]. The concentrations detected are low (ng/L - μg/L) but, due to the very nature of these compounds, studies have shown damaging effects on the aquatic ecosystems [1].
Several different processed natural materials can be used as filter media in water and wastewater treatment systems. Some of these materials can additionally present functions which extend beyond the simple process of filtration. Their surface areas can constitute a support for microbial population growth in biofilters as well as support matrix for the development of macrophytes in sub-surface flow constructed wetland systems (SSF-CWS) [2] which are increasingly being used in sewage tertiary treatment. The efficiency of these biological systems in the removal of xenobiotics can be significantly enhanced by a greater capability of the support matrix to retain contaminants by sorption phenomena, ionic exchange or other physico-chemical processes [2].
The aim of the present work was to evaluate the efficiency of two different materials namely, Light Expanded Clay Aggregates [LECA] (in two different particle sizes) and sand, for the removal from water of three acidic PhACs, clofibric acid, diclofenac and ibuprofen. In addition, relationships were established between the compounds removal efficiencies and the physico-chemical properties of each material.
A series of batch essays were carried out to study the sorption capacities of the different materials for the 3 chemical compounds. The influence of some experimental conditions, such as the contact time, the initial PhACs concentrations (1 mg/L up to 50 mg/L) and LECA particle size, were investigated. The media were sterilized before use in order to minimize any microbial development on the matrix and experiments were conducted in the dark to avoid any photocatalytic degradation reactions. The mineralogical composition of the materials was determined by X-ray diffraction and some physico-chemical properties were characterized. Samples of the contaminants' aqueous solutions were collected over a range of contact times with the support matrix and the remaining concentrations in solution were determined by UV/Vis spectrophotometry.
The results show that LECA has a good sorption capacity for acidic compounds. In contrast, sand does not exhibit any sorption capacity for any of the compounds tested. Not surprisingly, LECA with smaller particle sizes show higher efficiencies that larger grade LECA, due to a larger available surface area. However, the use of these smaller particle media at upper scales may present problems with hydraulic conductivities.
From the results obtained, it can be concluded that expanded clay presents important advantages as a CWS support matrix or as a filter medium, because it has a good sorption capacity, a pH buffer capacity and an excellent control of hydraulic permeability. On the other hand, sand does not exhibit any sorption capacity that might enhance the performance of filters and CWS in the treatment of water contaminated with this type of contaminants.

References
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