PHOTOCHEMICAL DEGRADATION OF THE ANTIDEPRESSANT SERTRALINE BY UVC/PS & UVC/H₂O₂ PROCESSES IN SYNTHETIC WASTE WATER

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In recent years the rapid development of pharmaceuticals (PhACs) has been an important scientific achievement as they have contributed to the treatment of serious diseases. However, these substances appear to have a negative impact on the environment due to their presence in various aquatic systems [1-3]. The continuous production and consumption of PhACs results in the release of active pharmaceutical ingredients (APIs) into the ecosystem either as the parent drug or as their metabolites [4]. More than 160 different pharmaceuticals have been detected in surface water, groundwater, effluents of WWTPs and drinking water, in concentrations ranging from a few ng/L to μg/L [2,5]. The PhACs categories that have been detected in the environment include antibiotics, non-steroidal anti-inflammatory drugs (NSAIDs), beta-blockers (β-blockers), antipileptic drugs and antidepressants. The selective serotonin reuptake inhibitors (SSRIs) belong to the prevalent class of antidepressants and used to treat mental illness. The main sources of SSRIs input to the aquatic environment are effluents from WWTPs and hospitals [6]. Recently, SSRIs have detected in different countries and aquatic systems, at high and low concentrations levels, ranging from ng/L to few mg/L [7].

Sertraline (SER) belongs to the selective serotonin reuptake inhibitors (SSRIs) and is administered for the treatment of major depression and others symptoms such as panic and anxiety. SER has determined in wastewater and surface water in the range of a few ng/L and up to 200 ng/L [8]. SER is a chemically stable substance and its removal rates from WWTPs are low to moderate (i.e., 28-45%) [6]. Its ineffective removal (as well as other pharmaceuticals), makes it necessary to upgrade the treatment methods in the WWTPs, especially when their treated effluents are intended for reuse such as for irrigation purposes [1].

The application of Advanced Oxidation Processes (AOPs) is a possible solution for the improvement of pharmaceuticals degradation [6]. AOPs are based on the oxidation of organic substances by in situ generation of various reactive oxygen species, such as hydroxyl radicals, HO· and sulfate radical anions, SO₄²⁻ [9]. Among them, UVC/H₂O₂ and UVC/PS methods, present particular interest.

In present study, the photochemical degradation of the antidepressant SER by UVC/H₂O₂ and UVC/PS processes in synthetic waste water (SWW) was investigated. Specifically, the effect of various parameters was studied, such as the concentration of the oxidant (Figure 1) and the water matrix, while the kinetic study of the photochemical decomposition of SER was performed. Moreover, the pseudo-first order kinetic constant, k_{obs}, and the electrical energy per order, EE/O_UV, were calculated as well as the total cost per order, Cost/O_total for each system. According to the results, the complete degradation of SER was achieved in both systems, even in a more complex aqueous matrix, such as SWW. It is characteristic that even at low concentrations of oxidant (i.e., 0.5 mM), more than 95% SER degradation was observed in a short time of irradiation (i.e., less than 15 minutes). Moreover, it was found that SER photochemical degradation follows pseudo-first order kinetic. Finally, it was found that the addition of oxidant (H₂O₂ or PS) minimizes the energy requirements of both systems.
Figure 1. Effect of oxidant dosage on SER photochemical degradation by (a) UVC/H₂O₂ and (b) UVC/PS. The experiments were performed in SWW and pH=7.5. The initial SER concentration was (a) 9.82 ± 0.44 μM, and (b) 10.15 ± 0.44 μM for the UVC/H₂O₂ and UVC/PS systems, respectively.

References


