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Water treatment adsorption and UV photodecomposition processes for antibiotics: Cephalexin and Amoxicillin

A.S. Reis, S.N. Guilhen , N. Ortiz

Centre of Environmental Chemistry – CQMA
Institute for Nuclear and Energy Research – IPEN
Av. Lineu Prestes, 2242 – USP São Paulo- Brazil
nortiz@ipen.br

Abstract: The developed of water treatment process to adsorb and decompose the pharmaceutical antibiotic amoxicillin and cephalexin using iron oxide –hematite, quitosan and UV radiation. The equilibrium time te= 180 min and the removal percentage for amoxicillin was 90% similar with those found in literature. In same experimental parameters the Cephalexin removal percentage was 25% some parameter have been alter to promote the photodecomposition such antibiotic mixture. The results confirm an indicate the possible use of UV photodecomposition reaction as a promising water treatment to treat, adsorb and decompose antibiotic residues in the environment.

Keywords: Cephalexin; Amoxicillin; Photodecomposition

Introduction

In 2012, Cephalexin (CEP) was one of the top 100 most prescribed medications in the United States. In Canada, it was the 5th most common antibiotic used in 2013. In Australia, it is one of the top 15 most prescribed medications. Is a common knowledge of the antibiotics as amoxicillin (AMOX) and cephalexin (CEP) are important advance in human medicine but their increase production, consumption and water discharge can pose a great threat to human health. The antibiotics use in health animal feed can promote the animal growth and a preventive effect against the diseases of contained livestock and poultry. However, the antibiotics used in such large quantities are not fully metabolized and the residue has been discharged into the environment along with the excretions (Chen et al., 2009).

The antibiotics presence in water bodies is the main responsible for increase bacterial resistance and promote the carcinogenic, teratogenic and mutagenic effects including the possible interference in physio-logical functions of human body. Brazil has a cattle herd estimated at 205 million heads in continuous growth and has made advances in such productivity rates. In the last 10 years, productivity in heads per hectare increased 25%. Even after the conventional water treatment, the produced wastewater and the sludge still contains antibiotic residues. Some studies have been performed to remove antibiotics from sewage and polluted water resources. Ion exchange resin, activated carbon and molecular sieves can be used as adsorbents to remove CEP and AMOX from surface water (Kong, 2015). The use of adsorption process followed by photodecomposition has been showing promising results to remove and decompose antibiotic residues before the water discharge in surface waters resources. The antibiotic content used in the investigation was based on the published measurements for AMOX and CEP following the adsorption and UV-photodecomposition processes. The processes were studied with the determination of the removal percentage.

$$R= (Ci-Ce)/Ci \qquad I$$

Where: Ci= Initial antibiotic concentration (mg L^{-1}) and Ce= Equilibrium antibiotic concentration (mg L^{-1}). The equilibrium condition was stablished at te=180 min, Figure 1.

Materials and methods

A UV-photodegration chamber was built, using a GE UV lamp fixed on 10 cm distance from de magnetic stirring plat. A becker was used with 200 mL of synthetic antibiotic solution, the stock solutions has 5.0 mg L^{-1}, the solution was diluted to perform each experiment. The 0.05 to 0.5 g of iron oxide (hematite) was weight and added with 0.03 g of quitosan to promote the AMOX and CEP adsorption and UV photodegradation. All aliquots of amoxicillin and the cephalexin solutions were collected on different time mixture as: 0, 30, 60, 90, 180, 240, 300 min and measured by UV-Vis- spectrophotometry Varian Cary E1, on 273 nm for AMOX and 260 nm for CEP.

The adsorption/UV decomposition systems were developed in temperature interval from 15-22 ^{o}C to avoid the formation of iron-cephalexin complex (Metal : Ligand) resultant for system temperatures higher than 50^{o}C (Mohammad, 2009). The equilibrium condition was obtained for both antibiotics systems after 180 min of continuous stirring, te = 180 min, Figure 1. The removal percentage for cephalexin and amoxicillin decomposition on equivalent processes parameters can be observed in Table 1.

Table 1: Removal percentage of adsorption and UV photodegradation processes

Figure 1: The comparison between Amoxicillin and Cephalexin adsorption/ UVdecomposition.

Conclusions

The use of hematite combined with quitosan under UV radiation result on 90% of removal percentage of amoxicillin. The decomposition of cephalexin was not effective in same processes parameters, the cephalexin molecule structure show higher stability for the system. The study confirm the promising results on sedimentation and decomposition of the most common antibiotic in use and measured with high frequency in polluted water. Such pharmaceutic compound has been considered one of the most responsible for the microorganism's adaptation and increasing bacterial resistance. The study confirm the possible use of low cost combined process with allows the adsorption and decomposition of one of the most stable pharmaceuticals reported in literature.

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References

Chen, L. Wang, Z., Ferreri, M., Su, J. and Han, B (2009)- Cephalexin residue detection in milk and beef by elisa and colloidal gold based one step strip assay. J Agric Food Chem, 57, 4674-4679.

Kong, Q, Wang, Y., Shu, L., Miao, M. (2015)– Isotherm, kinetic and thermodinamc equations for cephalexin removal from liquids using activated carbon synthesized from loofah sponge . Desalinition and water treatment.

Mohammad, A.A.-(2009) Determination of cephalexin by direct (UV-Vis) spectrophotometer and indirect (Flame Atomic Adsorption) technique. *Iraqui J. Pharm Sci*, vol 18(1).