Elimination of the Antibiotic Doxycycline Using a Helicoidal Flux Photoreactor: By-Products and Eco-Toxicity Assessment

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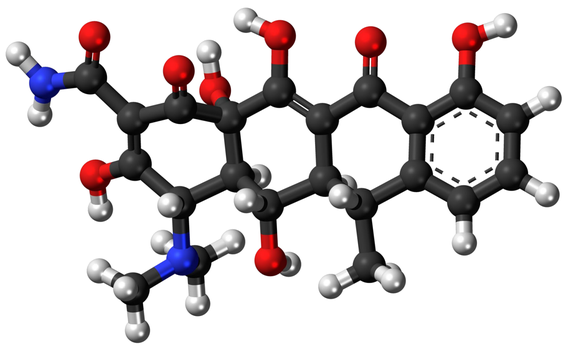
INTRODUCTION

Doxycycline (DOX) is an antibiotic belonging to the tetracycline family used in the treatment of infectious diseases caused by different types of bacteria and protozoa, it is the case of pneumonia, chlamydia, and cholera. Additionally, due to their incomplete metabolization, **antibiotics are excreted without modifications into the sewage system via urine or feces, which together with the fact that most of the wastewater treatment plants (WWTPs) do not have an appropriate design to remove them completely, they are discharged directly into water sources, which represents a potential risk for ecosystems, and even for humans, due to the proliferation of bacterial resistance. DOX has been detected in water bodies in some Latin-American countries like Brazil and Colombia.**



DOX molecular structure

METHODOLOGY

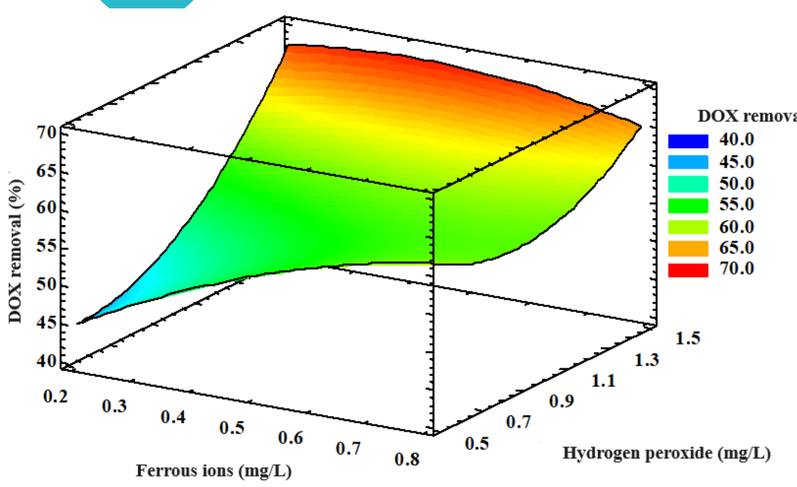
This research sought **to evaluate the use of a helicoidal flux photo-reactor and the application of the Fenton process (Fe + H_2O_2) in the removal of DOX**. The focus of the work was directed toward the analysis of the reaction byproducts using gas chromatography coupled to mass spectrometry (GC/MS) and the evaluation of the toxicity of the samples using luminescent bacteria (*Vibrio fischeri*).

Helicoidal Flux Photoreactor

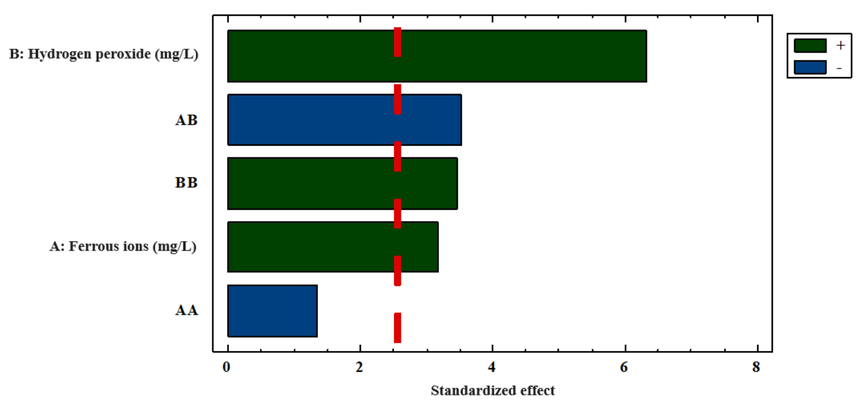
Optimized conditions

H_2O_2 concentration (mg/L)	1.5
Fe^{2+} concentration (mg/L)	0.4

RESULTS AND DISCUSSION



Response surface for DOX removal



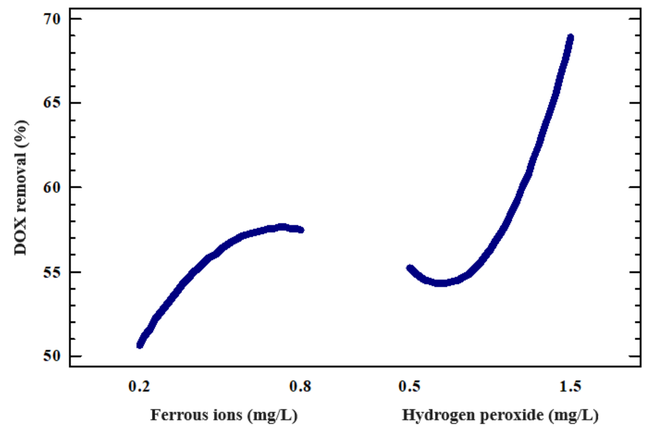
Pareto chart for DOX removal

Doxycycline removal was possible using Fenton and photo-Fenton.

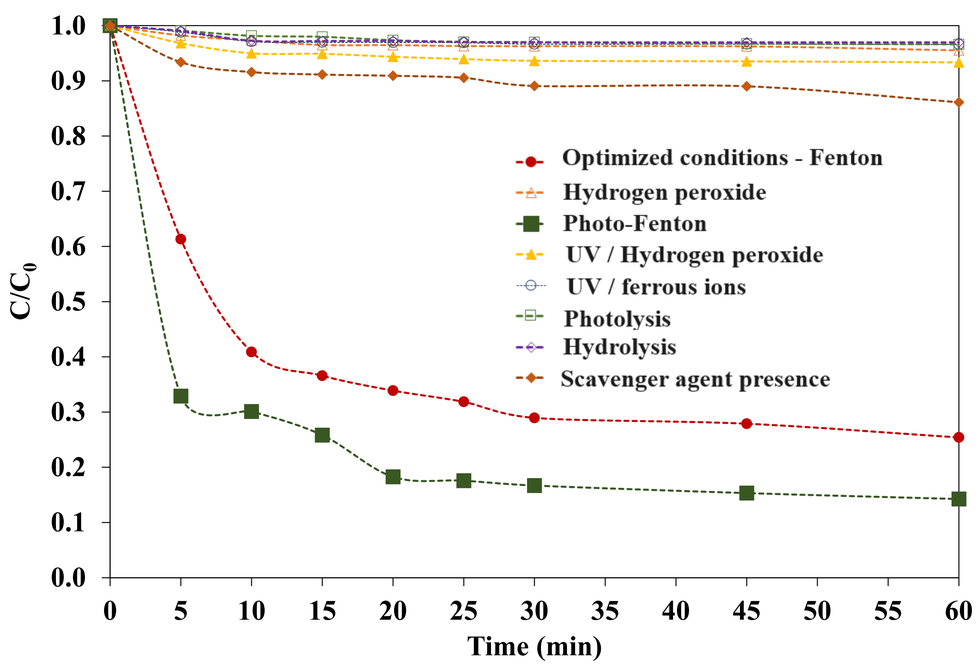
The configuration of the helical flux reactor favors the removal of the antibiotic.

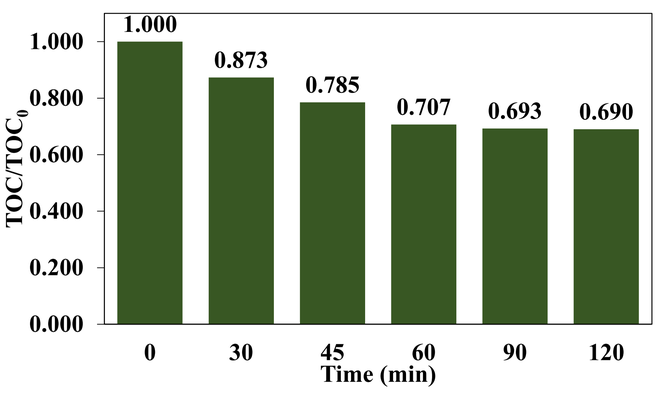
The hydroxyl radicals HO· are the main responsible agents for the removal of DOX.

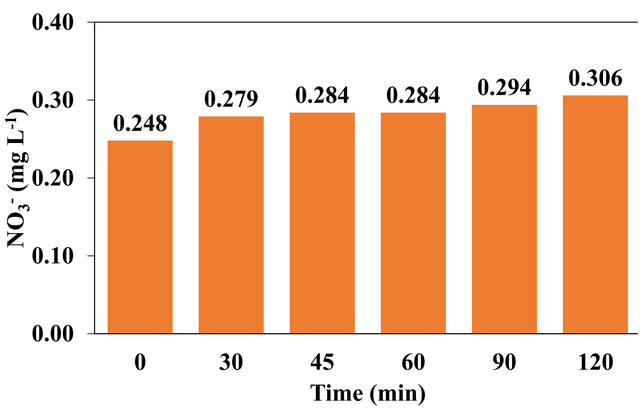
Hydroxylated by-products could be identified.

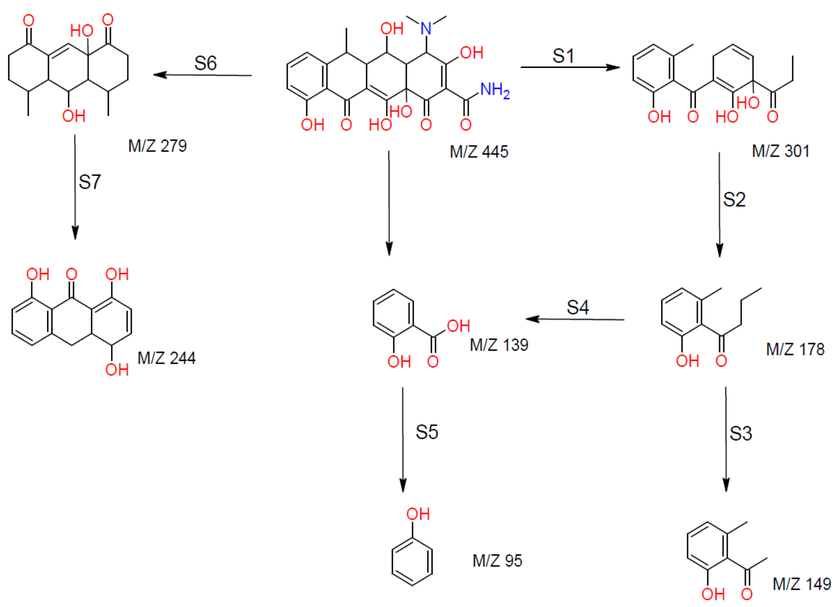


Main effects plot for DOX removal





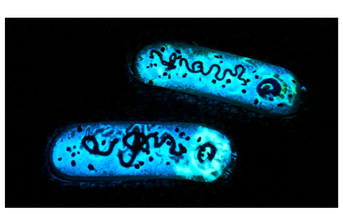




By-products identification

$$\text{Removal (\%)} = 38.081 + 67.640*Fe^{2+} - 16.729*H_2O_2 - 25.029*(Fe^{2+})^2 - 31.167\ Fe^{2+}*H_2O_2 + 22.990*H_2O_2^2$$

DOX removal under different oxidation conditions



Bacterial inhibition