TREATMENT OF ANTIBIOTICS BY BIO-FENTON PROCESS IN DIATOMS

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1. INTRODUCTION

Antibiotics are extensively used for human therapy, animal farming and for agricultural purposes. Residues from human environments and from farms may contain antibiotics and antibiotic resistance genes that can contaminate natural environments. Therefore, it is of great importance to develop efficient and cost-effective treatment technologies for removal of antibiotic from contaminated waters to minimize its ecological risks. . In the natural environment, many aquatic plants and algae are capable of producing hydrogen peroxide (H_2O_2) by their metabolic activities (Reis etal., and Inagaki etal.,). In our study, we used diatoms- one of the most dominant life forms in phytoplanktons which represents the largest group of biomass producers in the earth with a peculiar structure of stable silica frustule. The aim of this study was to identify the bio-Fenton reaction- by the diatoms- degradation of hydrogen peroxide produced by diatom cells to the hydroxyl radical in presence of different iron particles. The capability of diatoms to degrade the antibiotic by the bio-Fenton process was also studied.

2. MATERIALS AND METHODS

2.1 Enrichment of Diatom Culture

The diatoms were collected from a pond in Nishi Waseda Campus. Hogland's nutrient solution which contains 59.04 mg/L Ca(NO3)2_4H2O, 25.28 mg/ LKNO3, 24.65 mg L_1 MgSO4_7H2O, 6.80 mg/L KH2PO4, 2.26 mg/L Fe-EDTA (C10H12FeN2-NaO8_3H2O), 0.18 mg/L MnCl2_4H2O, 0.01 mg/L ZnCl2, 0.005 mg/L CuCl2_2H2O, 0.005 mg/L Na2MoO4_2H2O, and 0.286 mg/L H3BO3 was modified by adding sodium silicate for the enrichment of the culture.

2.2 Identification of Bio-Fenton Process

Batch experiments were conducted in 20mL beakers. In 10mL working volume phosphate buffer solution of pH 7.66, 10% inocula, 5mg/L Fe and 10µL amino phenyl fluorescine were used. The inoculated beakers were incubated for two days and the fluorescence were observed under a microscope.

2.3 Removal of tetracycline-HCl

Batch experiments were conducted to study the removal of tetracycline by the bio-Fenton process. Four reactors-R1, R2, R3 and R4 was kept to compare the removal rates by absorption, iron complex formation, bio-Fenton process and photo degradation respectively. The initial concentration of tetracycline in R1 was 600µg/L where as in the other reactors it was 800µg/L. 0.5mg/L of Fe as $FeSO_4$ and 0.0324mg/L dry weight correspondent inoculum was used.

3. RESULTS AND DISCUSSION

3.1 Identification of Bio-Fenton Process

The production of hydroxyl radicals as a result of bio-Fenton process confirmed by the fluorescence produced by the cleavage of Aminophenyl fluorescine by the diatoms in presence of an Fe catalyst (Fig 1). The mechanism of bio-Fenton process is explained in fig (2), and equations (1) and (2).

$$Fe^{2+} + H_2O_2 \rightarrow OH^{\bullet} + OH^{-} + Fe^{3+} \cdots\cdots (1)$$

$$Fe^{3+} + H_2O_2 \rightarrow OOH^{\bullet} + Fe^{2+} + H^{+} \cdots\cdots (2)$$

Key words: Bio-Fenton, hydroxyl radical, diatoms, antibiotic, tetracycline, treatment

Among the three iron particles viz. FeSO4, zeolite and colloidal iron, FeSO4 gave better results of bio-Fenton process compared to the other particles. Fig (3).

3.2 Removal of Tetracycline

Compared to photodegradation, absorption and iron complex formation, the bio-Fenton process gave better removal rate of tetracycline. So the bio-Fenton process is effective in removal of tetracycline from wastewater (Fig 4)

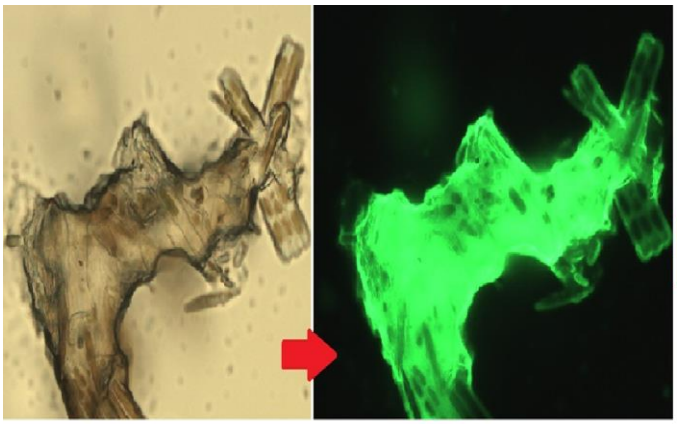

Fig 1. Identification of bio-Fenton process in diatoms

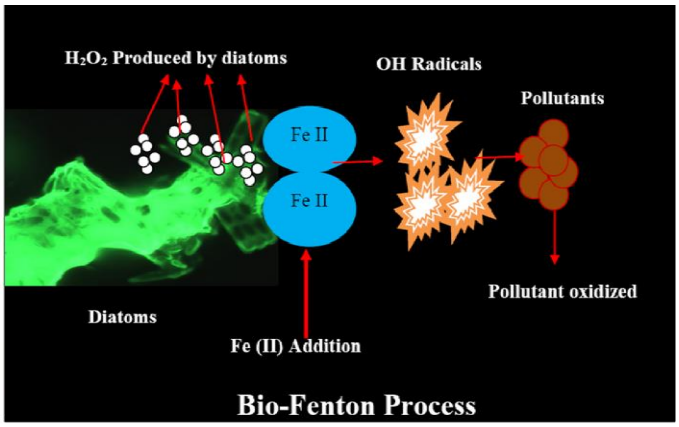

Fig. 2. Mechanism of bio-Fenton process in diatoms

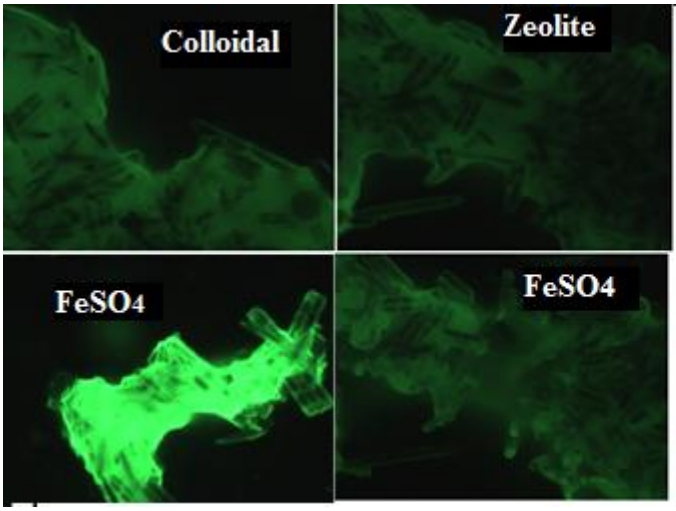

Fig 3. Comparison between different iron particles

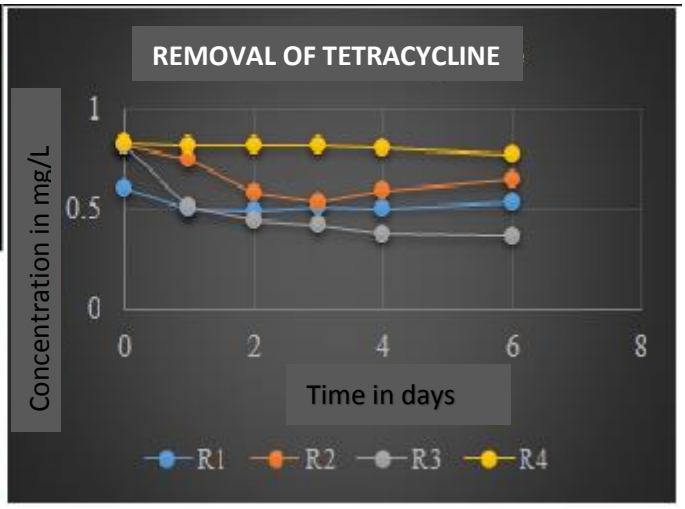

Fig 4. Removal of tetracycline

4. CONCLUSIONS

It is of great importance to develop efficient and cost-effective treatment technologies for removal of antibiotic from contaminated waters to minimize its ecological risks. The bio-Fenton reaction by diatoms and its capability to remove the tetracycline hydrochloride from water make it a promising footstep in the removal of antibiotics, and thereby the reduction of possibility of antibiotic resistant genes in the aquatic environment.

ACKNOWLEDGEMENT

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