APPLICATION OF BIO-FENTON PROCESS IN REMOVAL OF TETRACYCLINES IN SBR

Waseda University Regular member○ Ranjusha Vadakke Pariyarath

Waseda University Regular Member Prof. Sakakibara Yutaka

1. INTRODUCTION

In the natural environment, many phytoplanktons are capable of producing hydrogen peroxide (H_2O_2) by their metabolic activities. Diatoms are 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. In this study we identified the bio-Fenton reaction in diatoms- degradation of hydrogen peroxide produced by diatom cells to the hydroxyl radical in presence of different iron particles. Here, iron particles are the catalysts for the conversion of H_2O_2 to hydroxyl radical. Hydroxyl radical production in diatoms was confirmed using Electron Spin Resonance (ESR) technique, and removal experiments of tetracycline were conducted in SBR.

2. MATERIALS AND METHODS

A mixed culture of diatoms were used for the study.

2.1 Identification of Bio-Fenton process using fluorescence microscopy and ESR

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. The diatoms were mixed with trapping reagent, DMPO and Fe and the filtrate was analyzed using ESR spectroscopy. The settings of the ESR equipment were microwave power, 4mw; modulation amplitude, 0.1mT; field, 336.250mT; sweep width, 5mT; gain, 200 and time constant, 0.1s.

2.2 Removal of tetracycline-HCl in SBR.

Four sequence batch reactors R1, R2, R3 and R4 represents the control, iron complex formation, bio-Fenton and absorption reactors respectively. 0.5mg/L of Fe as $FeSO_4$ and 0.0324mg/L dry weight correspondent initial inoculum was used. Two runs for R2 and three runs were done for R3 and R4, where as in R1 tetracycline was not added further since there was no significant decrease in the R1.

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). The ESR signals of diatoms and Fe with trapping reagent was compared with the signal of 0.02mM H_2O_2, 1mg/L Fe and the trapping reagent. The comparable similar signals indicated the bio-Fenton process is successful in diatoms (Fig.3). But the peak height was too small, so we will consider more experimental conditions to get better peaks.

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

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

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 to remove tetracycline from contaminated water using SBR (Fig 4).

Key words: Bio-Fenton reaction, Tetracycline, Diatoms

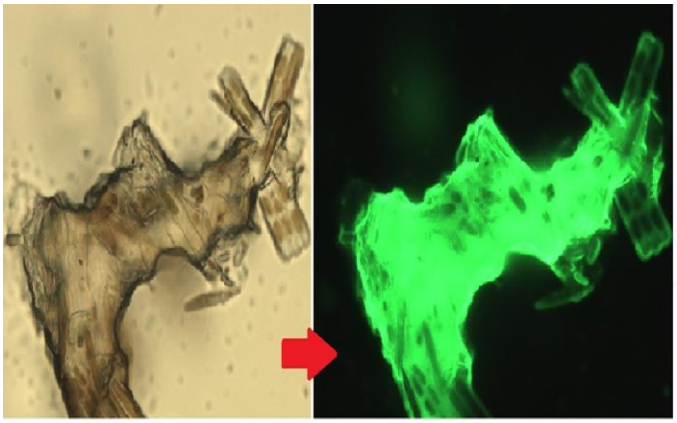

Fig 1. Identification of bio-Fenton process in diatoms

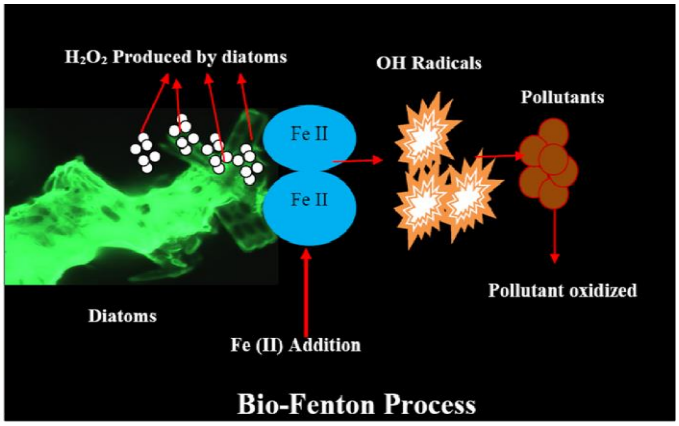

Fig 2. Mechanism of bio-Fenton process in diatom

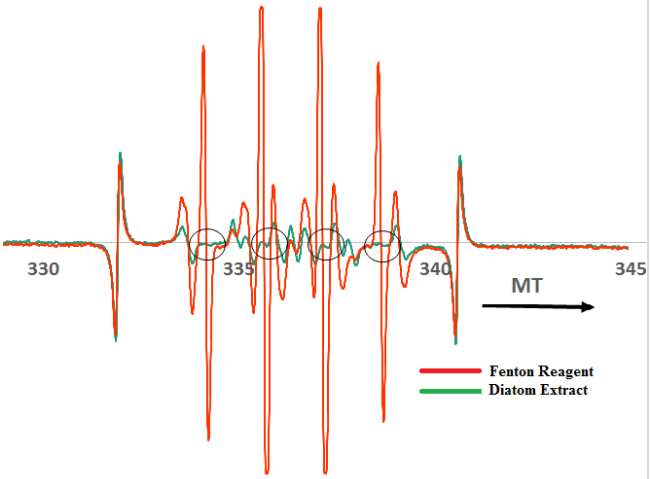

Fig 3. Comparison of ESR signals of diatoms and Fenton reagent

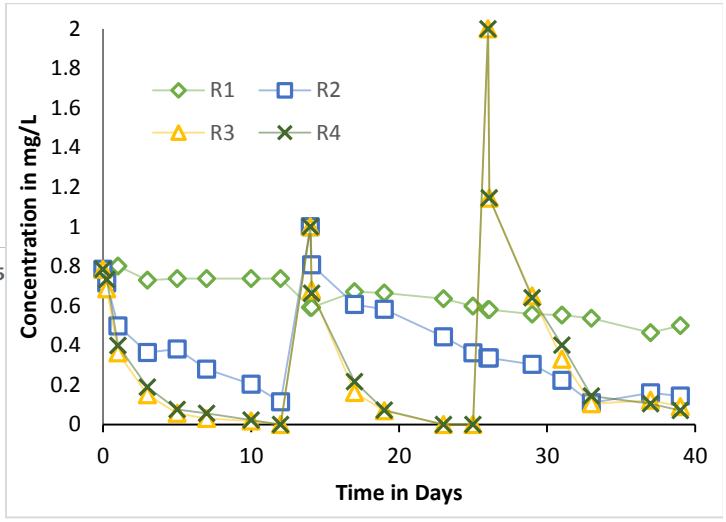

Fig 4. Removal of tetracycline in SBR

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 contaminated water makes it a promising footstep in the removal of antibiotics, and thereby the reduction of possibility of antibiotic resistant genes in the aquatic environment.

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