Evaluation of phytotoxic effects and decolorization of simulated and real textile wastewaters by UV/H_2O_2

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Abstract
In the present study textile dyes (Methylene Blue, Eliamine Blue F, Indigo) were used as model pollutants in water (ranging from 5 – 5000 mg/L) and real wastewater containing the Indigo dye was studied. The dyes in solution and the wastewater were treated by UV/H_2O_2 to study the influence of the type of dye, the initial concentrations of dye, the initial concentration of H_2O_2, the initial pH of the solution and the irradiation time in the dye decolorization of the treated solutions. The phytotoxic effect in *Raphanus sativus* of the treated and untreated dyes and wastewater in solution were evaluated.
Keywords: Wastewater, textile industry, UV/H_2O_2, phytotoxicity.

1. Introduction

The discharge of dyes in aquatic ecosystems is of environmental concern due to intense coloration and the possible toxic effects of these compounds on the environment (Hao *et al*., 2000). Therefore, the development of processes for the decolorization of textile dyes in wastewaters is of major importance. UV/H_2O_2 process is an effective method to decolorize water with dyes, but complete mineralization is not usually achieved for dyes (Aristizábal *et al.*, 2018). Different degradation products remained in the treated effluents, which can be toxic depending on the composition of the original water and the reaction conditions. (Nascimento *et al*, 2018). Due to these, it is necessary to evaluate the toxicity of water treated by UV/H_2O_2 especially if when discarded on the environment. Assessing the toxic effects of industrial wastewater and treated effluents on the environment is usually difficult. Seed germination tests are simple and inexpensive bioassays that are useful to evaluate Phytotoxicity of wastewaters (Priac et al, 2017). However, few reports in the literature focus on the evaluation of the decolorization and phytotoxicity of real wastewater after treatment by UV/H_2O_2.

The aim of this research it to evaluate the decolorization and phytotoxicity of synthetic waters and wastewater containing dyes before and after treatment by UV/H_2O_2.

2. Materials and Methods

Textile dyes were used as model pollutants: Methylene Blue (MB), Eliamine Blue F (EB) and Indigo (I). Solutions (5 – 5000 mg/L) of these dyes were used as model waters and real wastewaters (WW) containing the Indigo dye were used for the experiments. The reaction system consisted of batch reactors irradiated from the top by 5 UV-lamps (Philips TL-D ACTINIC BL). The dye solutions and the wastewater were treated by UV/H_2O_2 to study the influence of: the type of dye, the initial concentrations of the dye, the initial concentration of H_2O_2, the initial pH of the solution and the irradiation times in the dye decolourization, final pH and phytoxicity of the solutions. In these experiments, 25 ml of a solution were agitated and UV irradiated in the presence of H_2O_2. Color removal was evaluated by UV-Vis and phytotoxicity was determined by germination bioassay with *Raphanus sativus L*. seeds.

3. Results and Discussion

Decolorization process by UV/H_2O_2 of the three dyes in water were studied. MB required at least 180 min reaction time to achieve 100% decolorization compared to Indigo and Eliamine Blue F dyes which required 60 and 90 min of irradiation respectively. The differences could be attributed to the different chemical structures of these materials that interact differently with the UV and H_2O_2.

Figure 1 shows the effect of the type of dye and the initial H_2O_2 volume in the dye decolorization by UV/H_2O_2. MB and Indigo requires a higher reaction times than EB to achieve decolorization. A higher amount of H_2O_2 resulted in higher decolorization in time, however the increase in reaction rate varies with the type of dye.

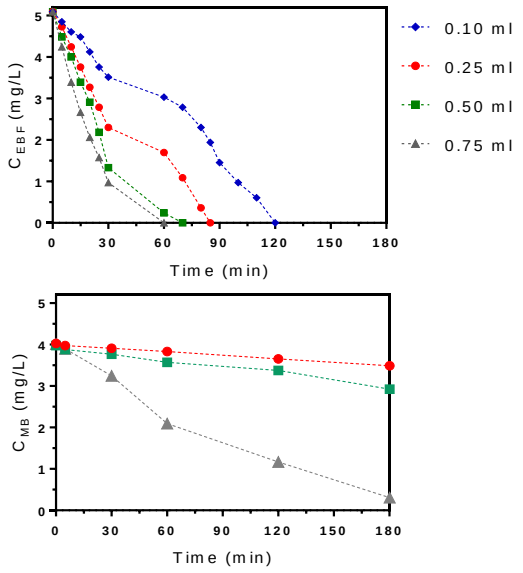

Figure 1. Effect of the initial H_2O_2 concentrations in the decolorization of Eliamine Blue F and Methylene Blue in water by UV/H_2O_2.

The effect of the pH in MB decolorization is negligible. The differences observed in dye removal by UV/H_2O_2 are attributed to differences in chemical structure of the dyes more than differences of the initial pH of the solutions (ranged from 3.2 to 7.4).

The real wastewaters show different UV absorption spectrum than the Indigo dye solution, because in the textile process other reagents were added that gave colour to the solution so direct comparison of decolorization is not possible. The wastewater did not show an intense blue coloration detected visually, indicating that most of the dye was attached to the fabrics during the textile process. The real effluent was treated by UV/H_2O_2 to achieve total decolorization and the UV spectra was monitored in time at different times. Real water decolorization required significantly higher irradiation time (32h compared to 60 min) than synthetic waters, but it was possible to achieve total decolorization. At the 22h of reaction time a green intermediate was observed that also was decolorized, which is interesting because the synthetic water did not show color changes in the UV-vis spectrum just decrease in intensity.

The seeds germination of *Raphanus sativus* data indicate that 2000 ppm of EB, 100 ppm MB and 100 mg/L I dyes in water and the WW, inhibit the first stage of development of the tested plants before and after treatment with UV lamps. These concentrations are considerably higher than the observed in real wastewaters. After treatment by UV/H_2O_2, the phytotoxicity of the textile wastewater increases after treatment.

4. Conclusions

The UV/H_2O_2 totally decolorized dyes in synthetic waters and wastewaters. It was found that the initial H_2O_2 and the type of dye strongly influence the decolorization efficiency of the process and this is related to the dye structure. Dyes in synthetic waters showed phytotoxic effects at high concentrations (over 100 mg/L) that differ according to the dye. Wastewater increased its phytotoxicity measured by *R. sativus* germination bioassay.

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