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Adsorption and Photocatalytic Degradation of Pharmaceutical Amoxicillin using TiO_2 Nanoparticles in Aqueous Solutions: Oxidative Coupling as Spectrophotometric Method

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Abstract

Determination of Amoxicillin(AMX) drug using the oxidative coupling reaction of 4-amino antipyrine (4AAP) in the found of $K_3[Fe(CN)_3]$ in the basic medium to give a red-colored chromophore that estimated spectrophotmetrically at 508 nm. at 25ºC.The good reagent concentration of 4-amino antipyrine of 0.3gm/100 ml and use potassium ferricyanide as oxidant of 0.3gm/100 ml. the photo catalytic degredation of an aqueous solution of Amoxicillin has studied in the several conditions in the found of TiO2 Nano-particles Titanium dioxide suspension. The affect of several factor like weight of titanium dioxide, Amoxicillin concentration. Data appeared that, the photocatalytic degradation method was great at the beginning and then decreased with time. The photo catalytic degradation efficiency raise through increasing catalyst loading from 0.05 g to 0.2 g and lowering with the raise in catalyst loading. Appeared that the rate of photo catalytic degredation was increased with decreasing AMX drug concentration. also study Removal percentage (E%) of a real sample (mixture of pharmacauticals compounds) from aqueous solution find when time raise the absorption lowering and give greater removal percentage (E%) .

Keywords: *Adsorption , Removal ,Photocatalytic , Pharmacautical , Amoxicillin drug , Titanium dioxide nanoparticles , Oxidative coupling .*

Introduction

One of the ecological contaminants is pharmacautical products. Pharmacautical are most utilized to enhance health human and utilized for animal treating and also in agriculture. Between the pharmacautical products, antibiotics are the utmost and more utilized in the treating of bacterial infections in plants ,people and animals [1-3] .Antibiotics has been frequently useful in microbe inactivation , husbandry animal, chemical therapy, and agriculture. Amoxicillin (AMX), as a important broad-spectrum and semisynthetic antibiotic penicillin, have widely utilized in animal and drug veterinary [4-8]. advanced oxidation methods, like oxidation, oxidation ozone, light Fenton and semeconductor catalytic oxidation, require a great quantity of energy or substances to attain great enactment. Amid the numerous photo catalysts, TiO2 consider utmost communal and affective because of its unique conduction band position and surface structure TiO2 as an cheap, available commercially, and non-toxic photo catalyst has attracted raising attention for waste water treating [9, 10] . (TiO_2) has conceder as a hetero -generous photo catalyst and has demonstrated its potential of the degredation of organic composites in aqueous methods . A main difficulty encountered through this material is the time-consuming and uneconomic retrieval of Titanium dioxide and the need of great photo catalyst loadings [11-13].

Experimental

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Preparation standard solutions

preparing of *Amoxicillin drug* (500 mg/L) stock solution . through dissolving 0.5gm of drug *Amoxicillin* in D.W .The solution was completing to 500 mL for D.W. Concentrations of drug was estimation via finding out the absorbance at the characteristic wavelength utilizing a double beam UV/Visible spectrophotmeter (UV–Vis spectrophotmeter, Shimadza 1650). Calibration curves was plotted among absorbance and concentration of the solution drug.

Materials

Commercial powder TiO_2 were purchased for (Germany /sigma-Aldrich,) *Amoxicillin drug* (AMX) was supported via Hila Company of samara factory . chemical formula: $C_{16}H_{19}N_3O_5$ S, MW: 365.4 g/mol, λmax 509 nm] The chemical structure of amoxicillin (Figure 1) . Wholly chemicals utilized in this study was analytical degree and utilized immediately without moreover purification.

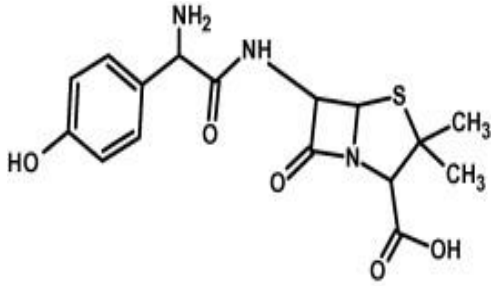

Figure 1: The chemical structure of amoxicillin ((2S.,5R.,6R.)-6-3,3-di-methyl-7-oxo-4-thia-1-azabicyclo[3.2.0]heptane-2-carboxylic acid).[3]

Photo catalytic experiments

The photo catalytic activity of the TiO_2 nanoparticles photo catalyst was assessed via the degradation of AMX drug waste water. Wholly data was carry out in a photoreaction vessel, of 100 ml of whole efficiency . A 125 W great-pressure mercury lamp . The beaker was put below the light of the ultraviolet preserve the dimension among the light source and the surface of the solution planned via utilizing UV A-meter (Dr. Honle/Germany).Prior for each test, the lamp was turned on and warm up of around 10 minute to obtain a constant out put. Batch tests were performed as the following procedure, 0.15 g TiO_2 photo catalyst additional in to 100 mL solutions drug, the mix was stirred in dark about 20 minute to allow adsorption physical of drug molecules on catalyst particles reaching the equilibrium.

Sample collected at uniform term and was promptly centrifuged to remove analysis particles .Determination of Amoxicillin drug using the oxidative coupling reaction of 4- amino antipyrine in the found of potassium ferricyanide in the basic medium to gave a red-colored chromophore that determination spectrophotmetrically at 508 nm. The best concentration0.3gm/100 ml of 4AAP was and 0.3gm/100 ml of the oxidant and calculated the calibration curve.

Effect of several factor like quantity of catalyst (0.05–2.0 g L^{-1}), and concentration of drug (10–50 mgL^{-1}) on the photo degradation capacity was studied. The removal

percentage E% of photo catalytic degradation of AMX drug and apparent first order rate constant was calculated utilizing the following relationships

$$\text{PDE}\ (\%) = (C_0 - C_t)/C_0\ 100\ \times \qquad (1)$$

$$\left(\frac{C_t}{C_0}\right) = e^{-kt} \qquad (2)$$

Where, C_0 and C_t are the primary and photolyzed conc. (mg/L), at the same order , (photo catalytic degradation efficiency) PDE, k is the apparent first order rate constant (min^{-1}) and t is time of irradiation (min.).

Results and discussion

Absorption spectra

The formation of panic-colored compound was employed in the quantitative detection of amoxicillin with 4- aminoantipyrine existence of K3[Fe3(CN)6] , when AMX was firstly mix with potassium ferricyanide in basic medium with reagent 4-aminoantipyrine, red-colored compound was formed with maximum absorbance in the visible at 509nm[8] as shown in Figure 2.

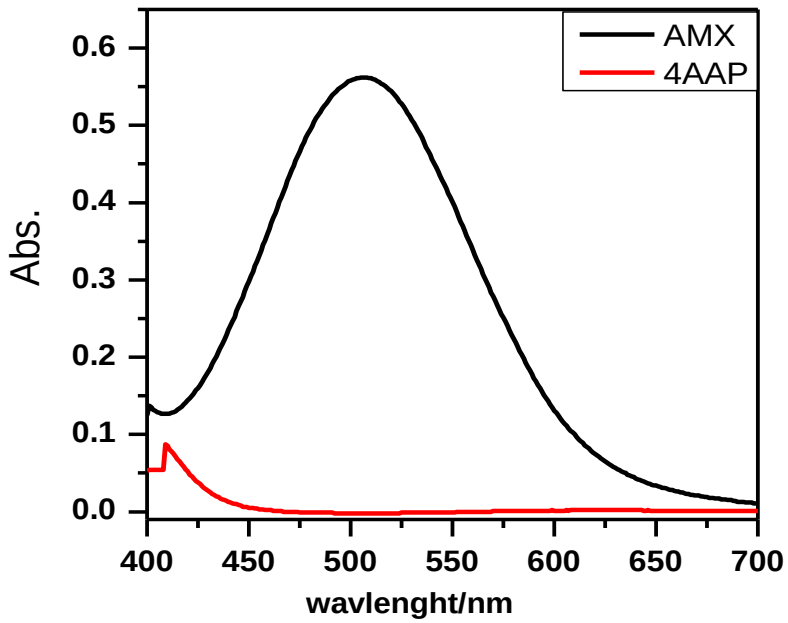

Figure 2: Absorption spectra solution of AMX of ($100mgL^{-1}$) against reagent blank.

Effect of reagent and oxidant concentration

The affects of various quantities of 4AAP reagent and oxidant potassium ferricyanide were studied. The highest absorbance and maximum color intensity of the complex were achieved with 0.3gm/100ml of reagent 4AAP and 0.3gm/100ml of oxidant potassium ferricyanide solutions [8] show in (Figure 3).

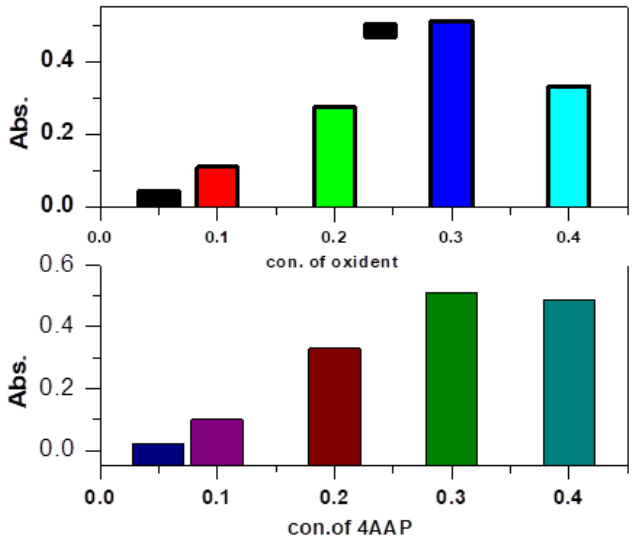

Figure 3 : Optimum absorption of compound in the presence of different conc. of reagent and oxidant .

Effect of weight dosage

The influence concentration of the photo catalyst (0.05-2 g/L^{-1}) in the photo catalytic degradation of drug AMX was inspected at an primary drug AMX conc. of 10 mg/l , (0.94 µens. sec^{-1}) , light intensity flow rate of O2 (5 mL. min^{-1}) and concentration buffer of the suspension pH 6.[14] Figure 4, data indicates that the rate of photo degredation raise via raising the quantity of TiO2 to 2 g/L^{-1}. The data is consistent by several another research that they are the best quantity of loading catalyst [13, 15, 16]. When the conc. of the catalyst is under the best value, the affective surface of the catalyst and absorption of the light are the chief agent that estimation the photo catalytic degradation rate [16-18].

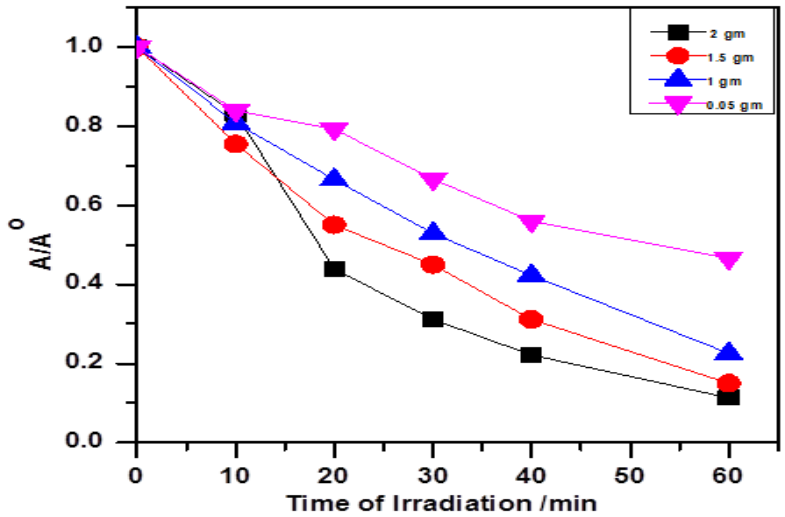

Figure 4. The effect weight of TiO2 on Photocatalytic degradation of AMX drug *Exp. Cond.: Temp. 25 ^{o}C, and L.I. 2.42 mW.cm-^{2}*

The Effect of initial AMX drug concentration on photo catalytic degradation processes :

The effect of alteration primary (10 – 50 ppm) on Photo catalytic degradation method of AMX drug was studied utilizing 0.15/ 100 cm3 , the light intensity equal to1.4 mW/cm2, and temperature at 298 K . The data appear in Figure 5 .It has been observed that the rate of Photo catalytic degredation slowly lowering with the raising of primary concentration primary AMX drug. This behavior might be give details, the conc. 10 ppm was the most favorable conc. to cover the major area of the TiO2 particles, thus absorbed maximum exciting photons to generate greater conc. of the activated TiO2 semiconductor [13, 19, 20].

The concentration of drug AMX drug 10 ppm have the most favorable Photo catalytic degradation capacity give 98% of one hour [21, 22]. The data of the change in removal Photo catalytic degradation capacity (E %) concentration of AMX drug plotted in Figure 6.

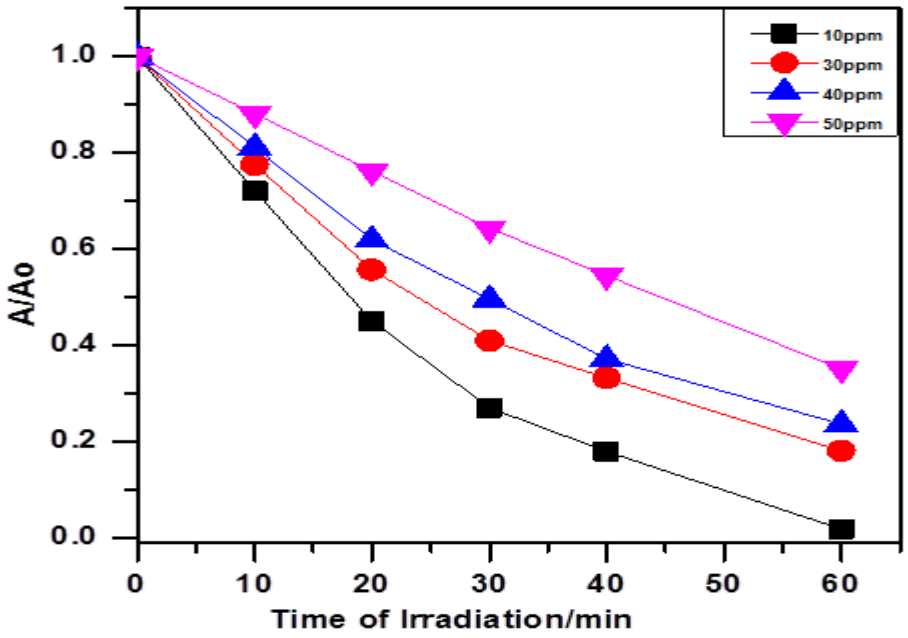

Figure 5 : Photo catalytic degradation of AMX drug at several primary concentration. Exp. Cond.: weight quantity 0.2 g.L-1, Temp. 25 °C, and L.I. 2.42 m.W.cm-

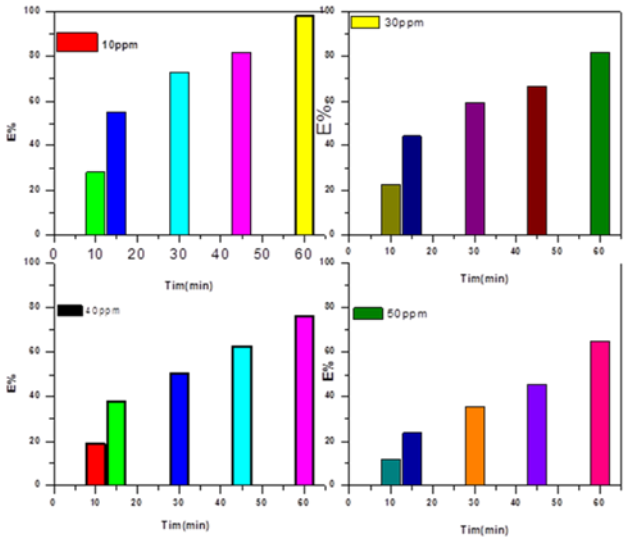

Figure 6 : percent removal AMX drug at several primary concentration. Exp. Cond.: weight quantity 0.2 g.L^{-1}, Temp. 25 ^{o}C, and L.I. 2.42 m.W.cm^{-2}.

Removal of a real sample (mixture of pharmaceuticals compounds) from aqueous solution.

A real sample 100 ml of pharmaceutical contaminants of a refry conc. was utilizing in this study, after that additional about 0.2 gL-1 of TiO2 in beakers , and put under the light ultraviolet preserving the space among the surface of the solution and the light source controlled via utilizing UVA-meter (Dr. Honle/Germany)of one hour , then isolated were detached via centrifuge and measured the residual conc. through utilizing UV-Vis. spectrophotmeter at selection wavelength at 273 nm without oxidative coupling appear in fig. 7 . and find when time raise the absorption lowering and give great removal percentage(E%) [23, 24].

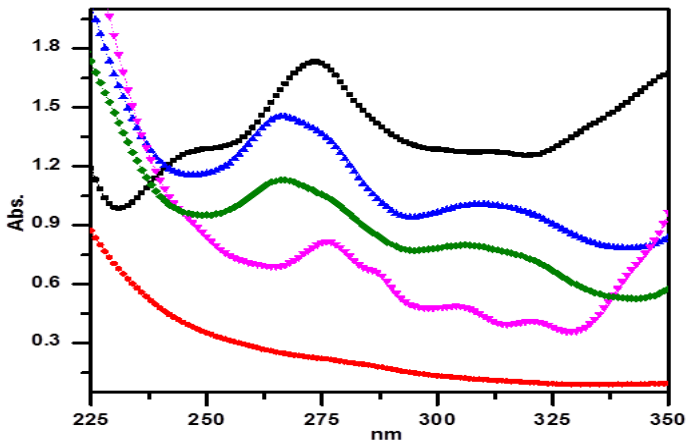

Figure 7: Effect Removal of the sample real (mixing of several pharmeceuticals compounds) via utilizing Titanium dioxide nanoparticles .

Concoction

The maximum concentration0.3gm/100 ml of 4-aminoantipyrine and 0.3gm/100 ml of $K_3[Fe(CN)_3]$ to gave great stability indeed greatly extra absorptivity to improve measurements and decrease mistake. The obtained data appear that AMX drug can be simply degraded via a TiO2 helped method in aqueous dis-persions below UV irradiation. The optimum Photo catalytic degradation capacity of the conc. *Amoxicillin drug* 10 mg/l give to 98% after one hour . Removal percentage of the sample real (mixture of pharmeceuticals compounds) from aqueous solution find when time raised the absorption lowering and give greater removal percentage. The data indicated that the light intensity and catalyst loading, the primary concentration of drug effected the degradation capacity of TiO2 powders obviously.

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