

Original Research Article

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## UV and Solar Degradation of Ofloxacin Antibiotic

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### ABSTRACT

#### Keywords

Photodegradation, photolysis, ofloxacin, UV radiations, fluoroquinolones.

#### Article Info

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The ofloxacin is a synthetic antibiotic, which belongs to the second generation of fluoroquinolones group. It acts against the Gram positive and Gram negative bacteria by inhibiting the DNA gyrase activity. The different concentrations of antibiotic solution ranging from 50 to 500 ppm, was exposed to the sun light and UV radiation. The solar exposure duration for the degradation, was 12 to 108 hrs. and UV exposure duration for the degradation, was 1 to 7 hrs. For the present study the UV radiation (15W and 30W) tubes, which were attached in the Laminar air flow, were used. The degradation capacity was measured by the zone of inhibition appeared after treatment. The maximum degradation of ofloxacin was recorded after 6 hrs. of exposure of UV (30W). The higher solar degradation was also recorded at 108 hrs. exposure duration, but degradation efficiency was lower than UV exposure. For the control of pollution in the environment caused by ofloxacin antibiotic residues, was significantly controlled by the treatment of UV and the photolysis.

### Introduction

Ofloxacin is a synthetic chemotherapeutic antibiotic having activity against gram negative as well as gram positive bacteria through inhibition of their DNA gyrase (Hubicka *et al.*, 2013; Sato *et al.*, 1982). This antibiotic belongs to second-generation fluoroquinolone. Its IUPAC name is 9-fluoro-2, 3-dihydro-3-methyl-10-(4-methyl-1-piperiziny)-7-oxo-7H-pyrido[1,2,3-de]-1,4-benzoxaine-6-carboxylic acid. It is widely used in the treatment of respiratory and urinary tract infections (Ichihara *et al.*, 1984). The ofloxacin shows its potential effects on agricultural soil micro flora and is

recently determined as antibiotic contaminated bio-solids in agricultural fields. However, it was observed that this was less affective to the soil microbial community function in comparison to the other antibiotics (Liu *et al.*, 2012). Several antibiotics present in soil are responsible for causing antibiosis, which is a natural defense mechanism with numerous soil microorganisms, producing antibiotics via their secondary metabolism (Thomashow *et al.*, 1997). Ferguson *et al.* (1988) observed the UV degradation of ciprofloxacin. Tiefenbacher *et al.*, (1994) investigated that

the photodegradation of fluoroquinolones, such as ciprofloxacin, ofloxacin and fleroxacin by ultraviolet irradiation and natural room light in liquid medium. Fluoroquinolone carboxylic acid was photodegradable in aqueous medium (Burhenne *et al.*, 1997a, b). Vasquez *et al.*, (2013) studied the degradation of antibiotic ofloxacin in waste water with the help of UV radiations in the presence of TiO<sub>2</sub>. Hubicka *et al.*, (2013) studied the degradation of moxifloxacin, ciprofloxacin, norfloxacin and ofloxacin in aquatic medium by ultra-violet exposure and noticed that these antibiotics were degraded in several simpler products. Santos *et al.*, (2015) investigated the photodegradation of norfloxacin antibiotic with the help of direct UV exposure, Fenton's oxidation process and photolysis in the presence of H<sub>2</sub>O<sub>2</sub> in waste water effluent.

Liu *et al.*, (2015) studied the photodegradation of antibiotics the florfenicol and thiamphenicol with the help of the exposure of UV irradiations and addition with H<sub>2</sub>O<sub>2</sub> and Fe (II) ions. Peres *et al.*, (2015) reported the degradation of ofloxacin antibiotic in liquid medium with the help of UV radiation exposure in the presence of TiO<sub>2</sub> as catalyst and the H<sub>2</sub>O<sub>2</sub>. Philips *et al.*, (1990) reported that after photodegradation, the antibacterial activity of ciprofloxacin was decreased. Sturini *et al.*, (2015) studied the solar photodegradation of four fluoroquinolones, the ciprofloxacin, danofloxacin, enrofloxacin and marbofloxacin and one penicillin, the ampicillin in treated waste water effluents. Ge *et al.*, (2015) recorded the direct solar light degradation of six fluoroquinolones, the ciprofloxacin, sarafloxacin, difloxacin, enrofloxacin, danofloxacin and levofloxacin in liquid medium. Tay *et al.*, (2015) recorded the degradation of ofloxacin antibiotic with the help of ozonation process in the aquatic

medium. They also recorded that in this degradation process many by-products were formed out of which some were harmful to humans. They further studied that the ozone and hydroxyl radicals were effected the ofloxacin degradation. In the present study authors have focussed the photo- and UV degradation of ofloxacin and determined the degradation by zone of inhibition.

## **Materials and Methods**

### **Chemicals and Media**

Ofloxacin 200mg (manufactured by Macleods pharmaceuticals Ltd. Solan, Himachal Pradesh, India) was used. The Muller-Hinton agar media (High media) was used for the determination of the zone of inhibition.

### **Experimental Setup**

#### **Effects of Sun Light on Antibiotics**

Different concentrations of ofloxacin antibiotic solutions (50, 100, 200, 300, 400 and 500 ppm) were prepared and poured in the petriplates for experiments. These plates were exposed to sun light during day time in the month of March in the Gwalior region (Madhya Pradesh, India) the temperature was 30°C, the sun light exposure was period ranging from 12-108 hrs. was observed. The antibiotic discs were prepared by dipping in the different concentrations of antibiotic, which were exposed to the sun light. The controls discs dipped in untreated antibiotic solutions were also prepared.

The bacterial culture was prepared in the petriplates containing the Muller-Hinton agar media The treated and control discs were placed in these petriplates. The petriplates, containing treated and control discs, were exposed to the environment of VRG PG College, Gwalior (M.P., India) for

bacterial culture for five minutes. After exposure these plates were incubated at 37°C for 48 hrs. The inhibition zones appeared in the petriplates was measured in millimeters (Jasim *et al.*, 2010; Chen *et al.*, 2011; Hernandez *et al.*, 2012).

### Effects of UV Radiation on Antibiotics

Different concentrations of ofloxacin antibiotic solutions (50, 100, 200, 300, 400 and 500 ppm) were prepared and poured in the petriplates for experiments. These plates were exposed to UV radiation in laboratory at 30°C temperature for the period ranging from 1-7 hrs. The UV-lamps (Philips, 15W and 30W) were used as source for UV radiation. The antibiotic discs were prepared by dipping in the different concentrations of antibiotic, which were exposed to the UV radiation. The controls discs containing untreated antibiotic solutions were also prepared.

The petriplates containing the Muller-Hinton agar media were also prepared for the bacterial culture. The treated and control discs were placed in these petriplates. These petriplates (containing treated and control discs) were exposed to the environment of

VRG PG College, Gwalior (M.P., India) for bacterial culture for five minutes. Then these plates were incubated at 37°C for 48 hrs. The inhibition zones appeared in the petriplates was measured in millimeters (Jasim *et al.*, 2010; Chen *et al.*, 2011; Hernandez *et al.*, 2012).

### Results and Discussion

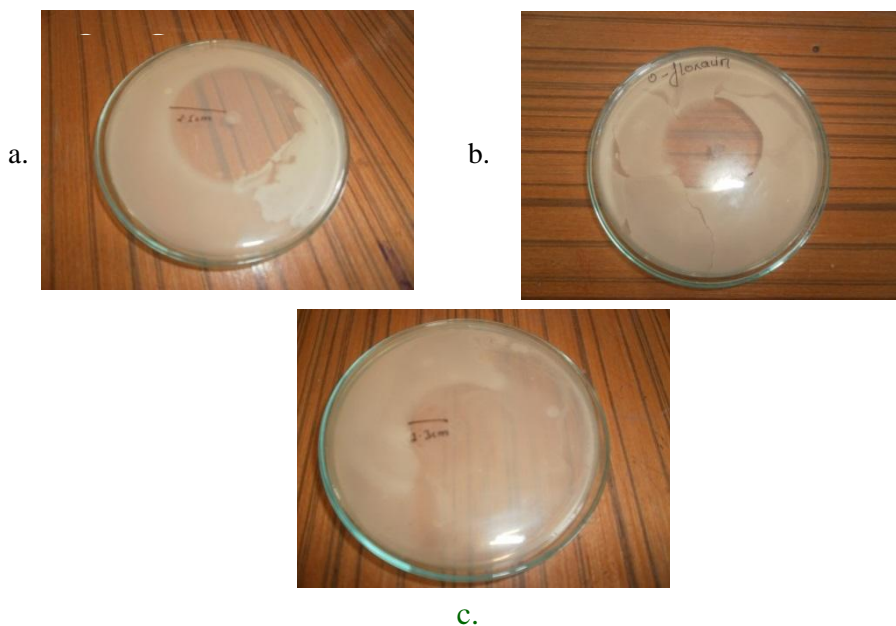
The experiment was set up to determine the UV degradation of ofloxacin by two UV intensities. The authors have recorded the higher degradation after 6hrs. of exposure of the ofloxacin at 15W UV tube. After 30W of UV exposure of also showed the higher degradation at 6hrs.of exposure (table 1 and 2, fig. 3, 4, 5, 6, 7 and 8). The degradation efficiency of ofloxacin antibiotic, after exposure of 15 and 30W UV radiation, increased continuously till 6 hours of exposure. The degradation rate became stable after 6 hrs. of radiation. The ofloxacin showed higher degradation after 108 hours of solar exposure at concentration 50, 100, 200, 300, 400 and 500ppm (table 3 and fig. 9). Degradation efficiency of solar exposure was maximum at 500ppm (figure 2).

**Fig.1** Chemical structure of ofloxacin modified from Application submitted by International Council of Ophthalmology.

Chemical formula: C<sub>18</sub>H<sub>20</sub>FN<sub>3</sub>O<sub>4</sub> (Rege *et al.*, 2011), Molecular weight: 361.37



**Fig.2** Ofloxacin degradation (a.) Zone of inhibition of 300ppm solution of ofloxacin without treatment (b.) and (c.)Zone of inhibition of 300ppm solution of ofloxacin after UV and solar treatment



**Table.1** Zone of inhibition (in mm) of the Ofloxacin with UV (15W) treatment

Con. → Exposure Time ↓	50ppm	100ppm	200ppm	300ppm	400ppm	500ppm
Non treated	15	18	19	21	23	25
1hrs	13	16	16	17	20	19
2hrs	12	13	14	13	17	13
3hrs	9	10	12	11	15	11
4hrs	7	9	8	6	11	9
5hrs	5	7	5	4	8	6
6hrs	3	3	4	3	5	4
7hrs	3	3	4	3	5	4

**Table.2** Zone of inhibition (in mm) of the Ofloxacin with UV (30W) treatment

Con. → Exposure Time ↓	50ppm	100ppm	200ppm	300ppm	400ppm	500ppm
Non treated	15	18	19	21	23	25
1hrs	12	15	14	15	19	18
2hrs	11	12	12	12	16	12
3hrs	8	9	10	10	14	10
4hrs	6	8	7	5	10	8
5hrs	4	6	6	3	7	5
6hrs	2	2	3	2	4	3
7hrs	2	2	3	2	4	3

**Table.3** Zone of inhibition (in mm) of the ofloxacin with sun light treatment

Con. → Exposure Time ↓	50ppm	100ppm	200ppm	300ppm	400ppm	500ppm
Non treated	15	18	19	21	23	25
12 hrs.	14	15	17	18	22	23
24 hrs.	13	14	15	16	18	21
36 hrs.	10	12	13	14	16	17
48 hrs.	9	10	11	12	13	12
60 hrs.	7	8	9	10	11	10
72 hrs.	5.4	6	7	9.5	10	8
84 hrs.	4	5	6	8	9	7
108 hrs.	3	3	3	3.5	4	5

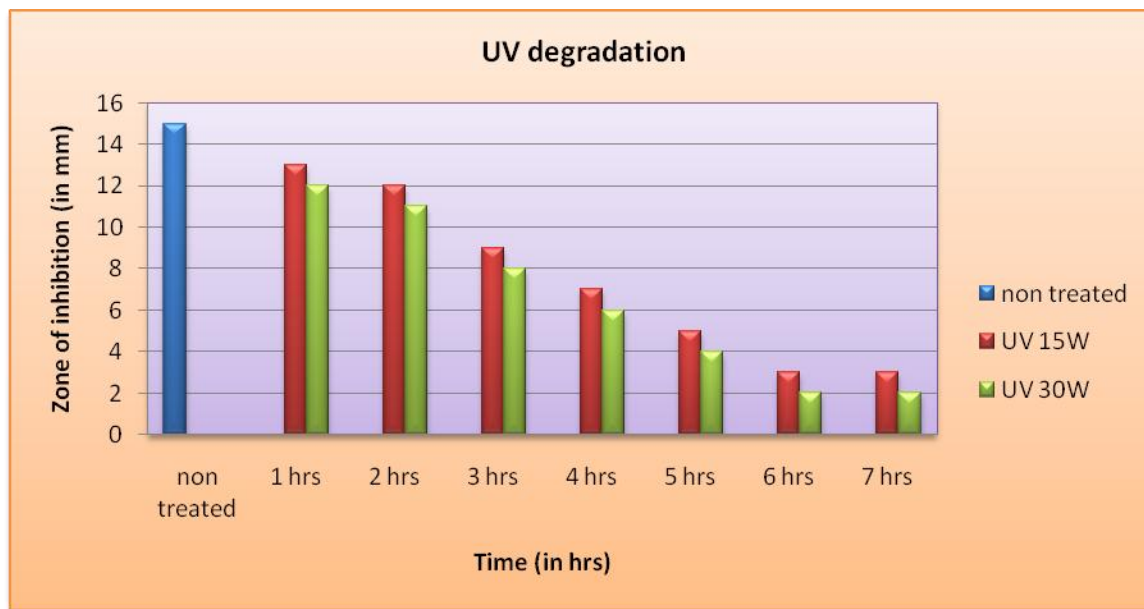


Fig.3 50ppm concentration of ofloxacin showing UV degradation

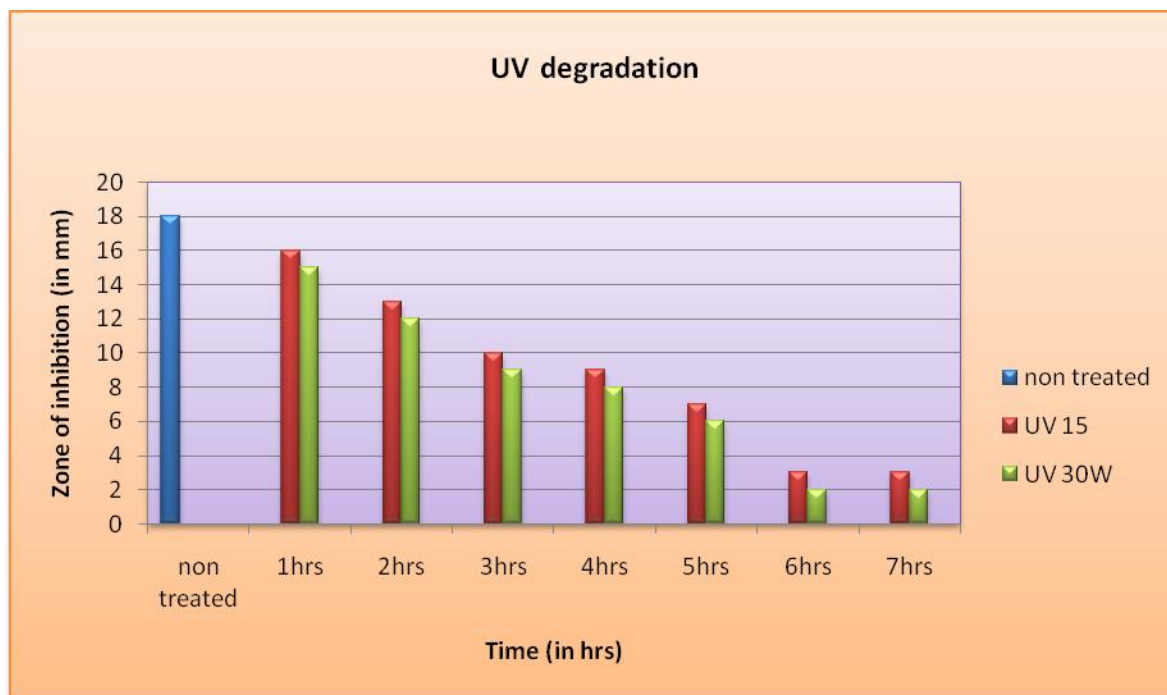
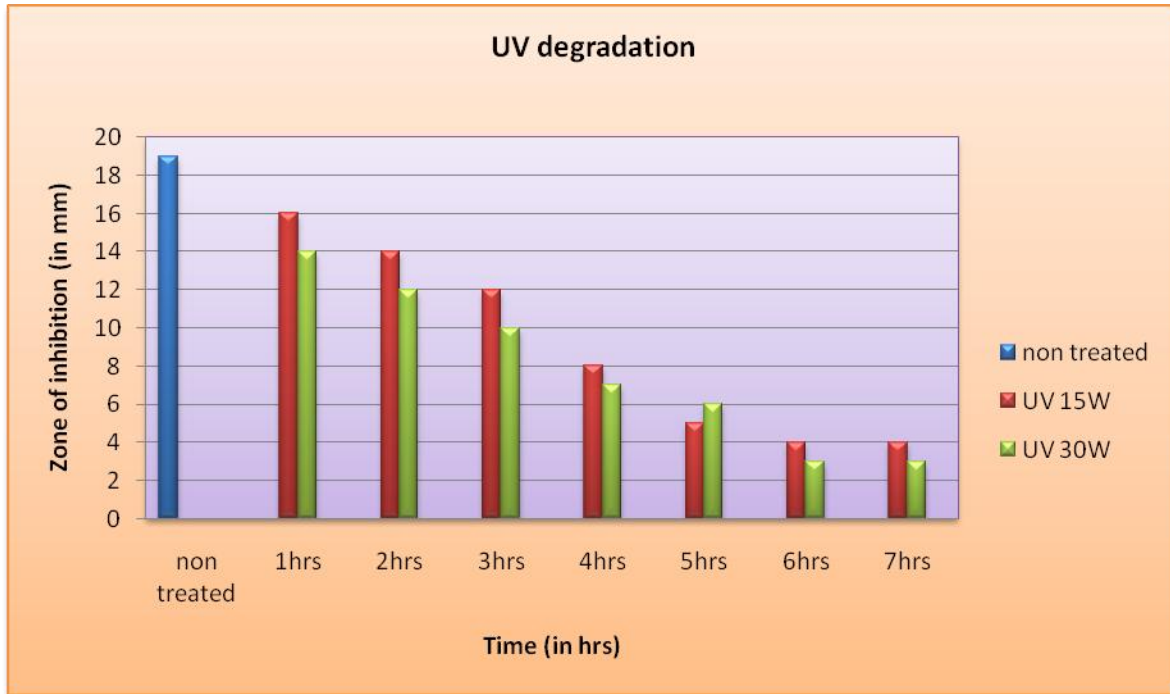
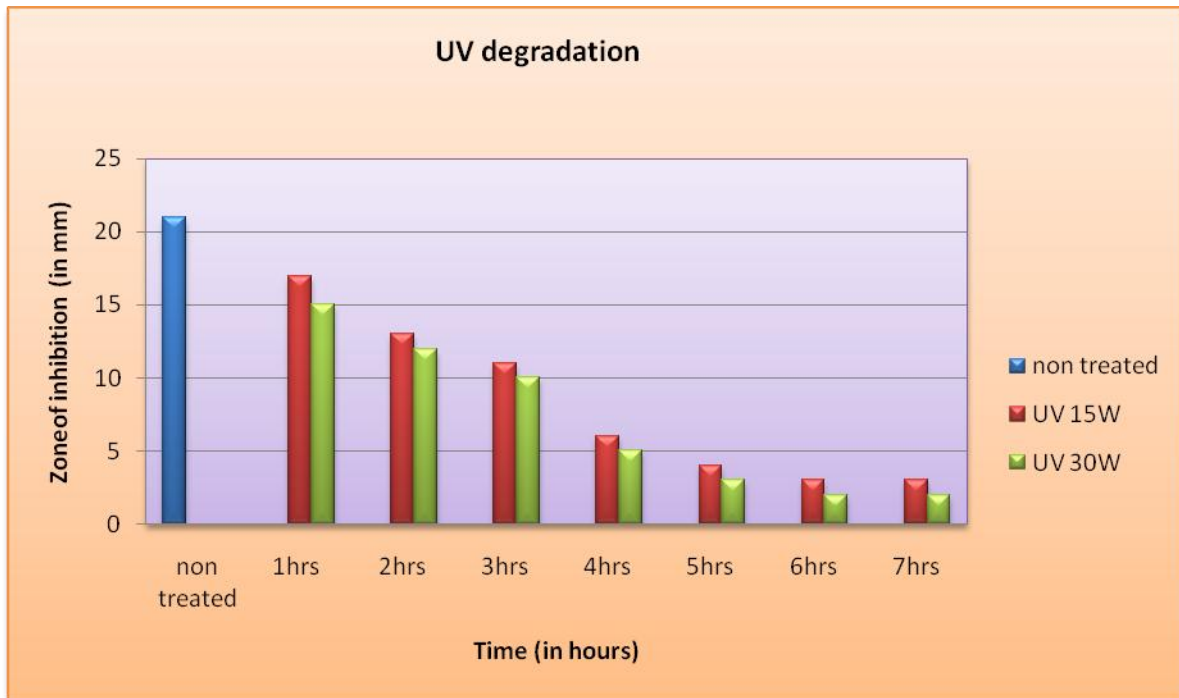


Fig.4 100ppm concentration of Ofloxacin showing UV degradation

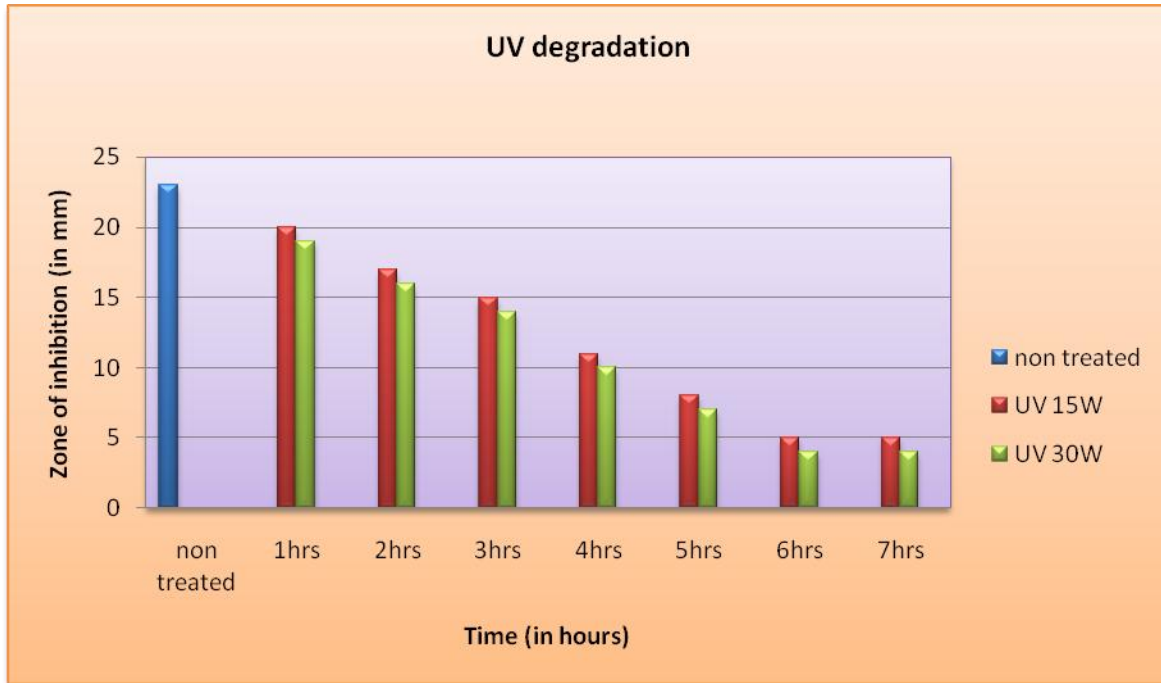


**Fig.5** 200ppm concentration of Ofloxacin showing UV degradation.

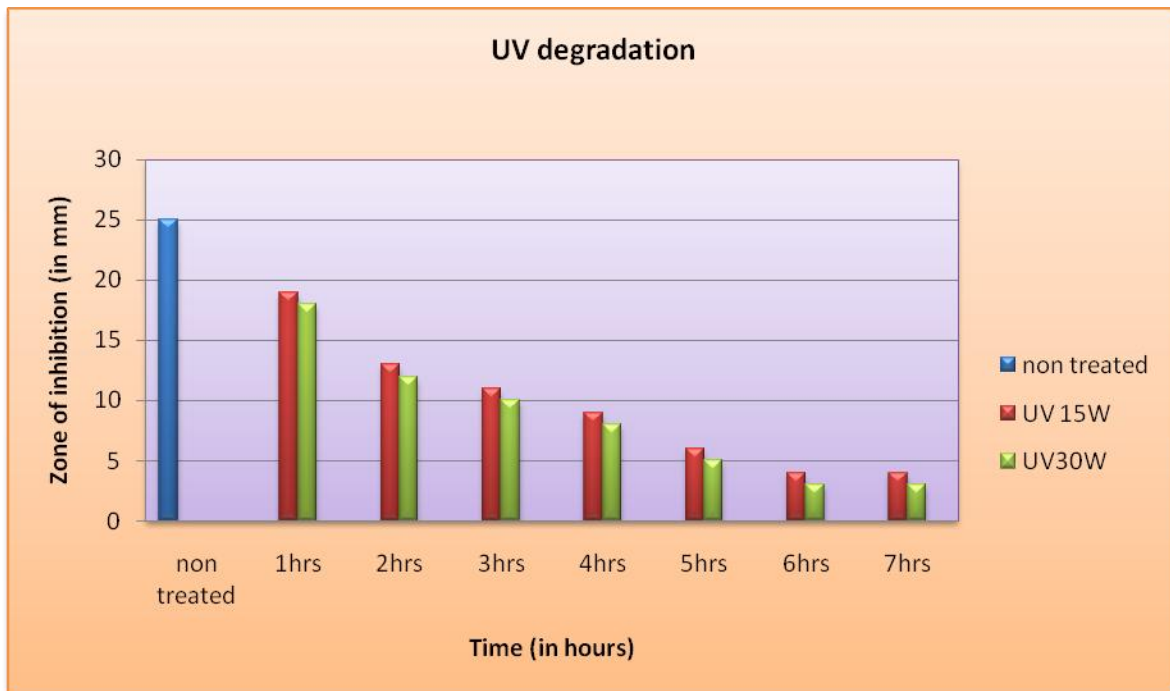


**Fig.6** 300ppm concentration of Ofloxacin showing UV degradation.



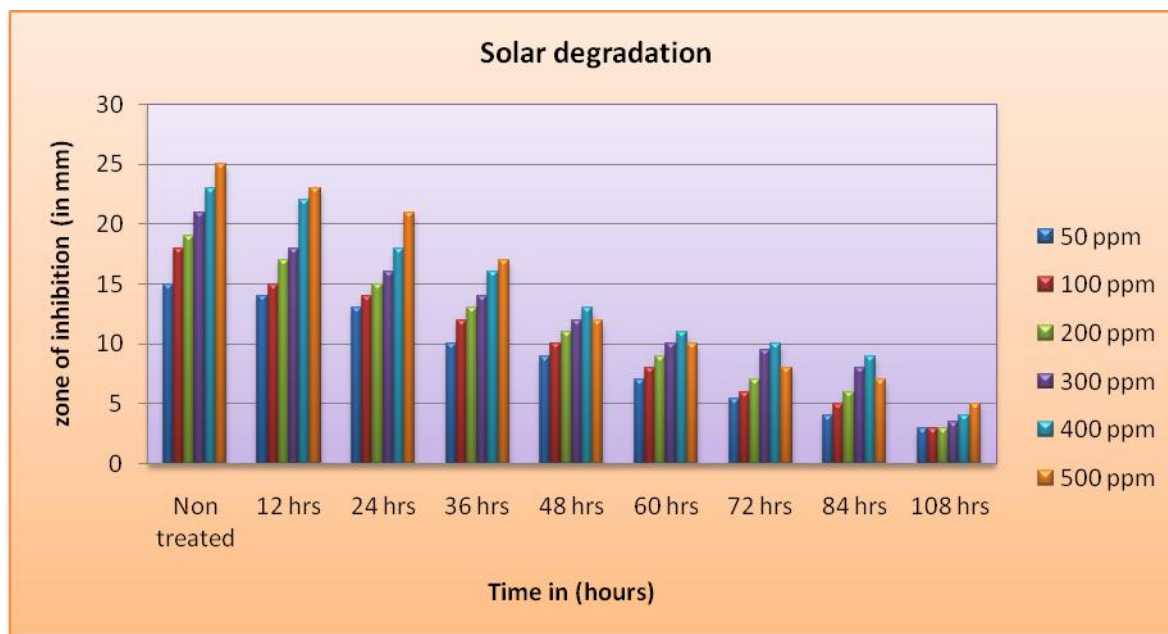


**Fig.7** 400ppm concentration of Ofloxacin showing UV degradation



**Fig.8** 500ppm concentration of ofloxacin showing UV degradation





**Figure.9** Ofloxacin showing solar degradation.

Bhakta *et al.*, (2009) have studied the photocatalytic degradation of sulphamethoxazole and trimethoprim antibiotics by applying the combined effect of TiO<sub>2</sub> and UV. They concluded that the degradation was slower when treated only with UV. They also noticed that degradation rate of sulphamethoxazole was faster to trimethoprim. Ge *et al.*, (2015) have studied the solar and hydroxyl radical oxidation of danofloxacin, ciprofloxacin, levofloxacin, difloxacin and sarafloxacin and enrofloxacin fluoroquinolones antibiotics oxidation in surface water. They also noticed that the rate of fluoroquinolones degradation was maximum after solar exposure than the hydroxyl radical oxidation. Peres *et al.*, (2015) have recorded the degradation of ofloxacin antibiotic with the help of UV/ TiO<sub>2</sub> and UV/ TiO<sub>2</sub>/H<sub>2</sub>O<sub>2</sub>. They also reported the degradation efficacy of UV/ TiO<sub>2</sub> was 89.3% in 60 minutes for ofloxacin and after addition of H<sub>2</sub>O<sub>2</sub>, the degradation efficacy increased to 97.8% and the concentration of photocatalyst also increased the degradation efficacy of ofloxacin.

In conclusion, the solar and UV degradation of ofloxacin antibiotic was studied. The UV degradation (15W and 30W) was best after 6 hrs. of the exposure and after this exposure degradation rate was stable. The solar degradation of ofloxacin was at lower rate in comparison to the UV exposure. All the concentration ranging from 50pp to 500ppm of the ofloxacin showed the higher degradation after 108 hrs. The authors have recorded the highest solar degradation efficiency at 500ppm. From the above observations it is concluded that the degradation of ofloxacin antibiotic present in the soil, garbage etc. can be possible in the fields also.

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