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Solar and UV Photolysis of Ampicillin Antibiotic Solution

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Abstract-The ampicillin shows broad spectrum antibacterial activity mostly against Gram positive bacterial group but it also shows such activities against some Gram negative bacterial group. The solution of concentration ranging from 50-500 ppm of the ampicillin was exposed to the sun light and UV radiation. The duration of the exposure, for the degradation by UV radiation, was 1 to 10 hrs. The UV rays (15W and 30W) lamps were used for the study. The degradation was measured by the zone of inhibition. The maximum degradation was recorded after 5 hrs. of duration by the exposure of UV 30W. The maximum degradation of the solar degradation was after 72 hrs. of the direct sun light exposure. The UV and the solar degradation proved to be the significant mode to control the environmental pollution caused by ampicillin residues.
Key words- Photolysis, Ampicillin, UV radiation and Environment.

I. INTRODUCTION

Antibiotics are molecules that kill or inhibit the growth of microorganisms, including bacteria and fungi both (Cundcliffe et. al., 2000; Dunkle et. al., 2010). Ampicillin is a semi-synthetic antibiotic belonging to the penicillin group, which consist β-lactam ring, thus it belongs to β-lactam group of antibiotics (Nascimento et. al., 2013). It shows broad spectrum antibacterial activity against Gram positive bacterial and some Gram negative bacterial group. This antibiotic is used for the treatment of meningitis, entero-coccal endocarditis urinary tract infection and prophylaxis for bacterial endocarditis (Sharma et al 2013). The antibiotics as human and veterinary medicine, has led to wide spreaded toxic pollution in the environment. The biological resistant antibiotics have been recorded in pre-treated sewage, industrial effluent, aquatic environment and also in drinking water (Klavarioti et al., 2009). Emolla et al., (2009) reported the photo-degradation of ampicillin, amoxicillin, and cloxicillin antibiotics with the help of photo-fenton process in aquatic medium. Elmolla et al., (2010) focussed on the aqueous degradation of amoxicillin, ampicillin and cloxicillin antibiotics in different operating condition such as UV, zinc oxide, concentration, pH and irradiation time and observed the rate of degradation of amoxicillin, ampicillin and cloxacillin antibiotics was highly affected by the pH. Wirzal et al., (2013) recorded that the degradation of ampicillin penicillin-G by oxidation method by using metal (mixed) oxide electrode as anode. Alalm (2016) recorded the photo-degradation of ampicillin antibiotic with the help of UV radiations in the presence of Ru, WO3 and ZrO2 catalyst in liquid medium. The main objective of this study was to determine the maximum rate the degradation of ampicillin antibiotic by sun light and UV radiation of different intensities.

II. MATERIAL AND METHOD

A. *Chemicals and Media*

Ampicillin 500mg (manufactured by Candila pharmaceuticals Ltd. Dholka, Ahmedabad, India) was used in the present study. The Muller-Hinton agar media (High media) was used for the determination of the zone of inhibition.

B. *Experimental Setup*

1) *Effects of Sun Light on Antibiotics:* Different concentrations of ampicillin 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 30^0C , the sun light exposure was period ranging from 12-108 hrs. was observed. The antibiotic discs were prepared by dipping them in the different concentrations of antibiotic, which were then 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 containing media. The petriplates, containing treated and control discs, were exposed to the environment of the institution for bacterial culture for five minutes. After exposure these plates were incubated at 37^0C for 48 hrs. The inhibition zones, appeared in the petriplates, were measured in millimeters (Jasim et al., 2010; Chen et al., 2011;

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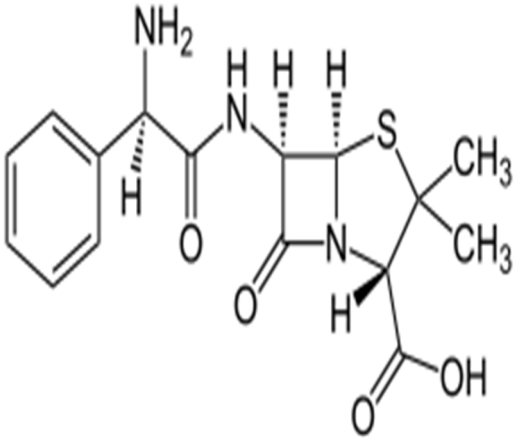
Hernandez et al., 2012).

2) Effects of UV Radiation on Antibiotics: Different concentrations of ofloxacin antibiotic solutions (50, 100, 200, 300, 400 and 500 ppm) were prepared for experiments as discuss above. These plates were exposed to UV radiation in laboratory at 30^0C temperature for the period ranging from 1to 10 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 used as controls. 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 were exposed to the environment of the institution for bacterial culture for five minutes. These plates were incubated at 37^0C for 48 hrs. The inhibition zones appeared in the petriplates were measured in millimeters (Jasim et al., 2010; Chen et al., 2011; Hernandez et al., 2012).

Structure of Ampicillin



Chemical fomula: $C_{16}H_{19}N_3O_4S$

Molecular weight: 349.41g/mol

IUPAC name: (2*S*,5*R*,6*R*)-6-([(2*R*)-2-amino-2 phenylacetyl] amino)-3,3-dimethyl-

7-oxo-4 thia-1 azabicyclo [3.2.0] heptane-2- carboxylic acid.

III. RESULT AND DISCUSSION

Emolla et al., (2009) have demonstrated the complete degradation of ampicillin, cloxacillin and amoxicillin at the concentration 105, 103 and 104 mg/l respectively after 5hrs. UV exposure and at pH 5. The percentage of ampicillin, cloxacillin and amoxicillin degradation was 3.8%, 4.9% and 2.9% respectively. Emolla et al. (2010) also studied the degradation of ampicillin, cloxacillin and amoxicillin at the concentration 105, 103 and 104 mg/l respectively but when the antibiotics were treated with UV/ZnO photo-catalysis they recorded that the complete degradation took place after 180 minute of exposure. Dehghani et al., (2014) have recorded that the UV radiations were most effective for the penicillin G degradation. They also noticed the photo-catalytic degradation rate of penicillin G was increased by UV radiation treatment.

In the present study the degradation efficiency of ampicillin was measured by the UV exposure of two intensities (15W and 30W). The maximum degradation of AMP was recorded at 30W of UV exposure after 5 hours but 15W exposure of UV indicated the maximum degradation was possible after 7hrs of exposure (Table 1, 2, fig. 1, 2, 3, 4, 5 and 6).The different concentrations (50 to 500ppm) of ampicillin antibiotic were degraded by the solar exposure at different time intervals (12hrs to 108hrs). The maximum degradation of ampicillin was observed after 72 hrs. (Table3 and fig.7).

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Table-1:- Zone of inhibition (in mm) of the Ampicillin with UV (15W) treatment.

Con. → / Exposure Time ↓	50ppm	100ppm	200ppm	300ppm	400ppm	500ppm
0hrs	9.0	11	13	15	18	20
1hrs	8.0	9.0	11	13	16	18
2hrs	6.0	8.0	10	12	14	16
3hrs	5.0	7.0	9.0	10	13	15
4hrs	4.0	5.0	7.0	9.0	11	13
5hrs	3.6	4.0	6.0	8.0	8.0	9.0
6hrs	2.9	3.0	4.5	6.0	7.0	7.6
7hrs	2.7	2.9	4.0	5.5	6.4	6.9
8hrs	2.6	2.8	3.9	5.4	6.3	6.8
9hrs	2.5	2.7	3.8	5.3	6.2	6.7
10hrs	2.4	2.6	3.7	5.2	6.1	6.6

Table-2:- Zone of inhibition (in mm) of the Ampicillin with UV (30W) treatment.

Con. → / Exposure Time ↓	50ppm	100ppm	200ppm	300ppm	400ppm	500ppm
0hrs	9.0	11	13	15	18	20
1hrs	7.0	8.0	10	11	14	16
2hrs	5.0	7.0	9.0	10	12	14
3hrs	4.0	5.0	7.0	9.0	10	11
4hrs	3.0	3.0	6.0	8.0	9.0	9.5
5hrs	2.2	2.3	4.0	5.0	6.5	7.0
6hrs	2.1	2.2	3.9	4.9	6.4	6.9
7hrs	2.0	2.1	3.8	4.8	6.3	6.8
8hrs	1.9	2.0	3.7	4.7	6.2	6.7
9hrs	1.8	1.9	3.6	4.6	6.1	6.6
10hrs	1.7	1.8	3.5	4.5	6.0	6.5

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Table-3:- Zone of inhibition (in mm) of the Ampicillin with sun light treatment.

Con. → / Exposure Time ↓	50ppm	100ppm	200ppm	300ppm	400ppm	500ppm
Non treated	9	11	13	15	18	20
12hrs	8	10	12	14	17	19
24hrs	7	9	11	13	15	17
36hrs	6	7	10	11	13	16
48hrs	5	6	8	10	11	14
60hrs	4	5	7	9	8	10
72hrs	3	3.8	4	5.0	7.0	8
84hrs	2.9	3.7	3.9	4.9	6.9	7.8
108hrs	2.8	3.6	3.8	4.8	6.8	7.6

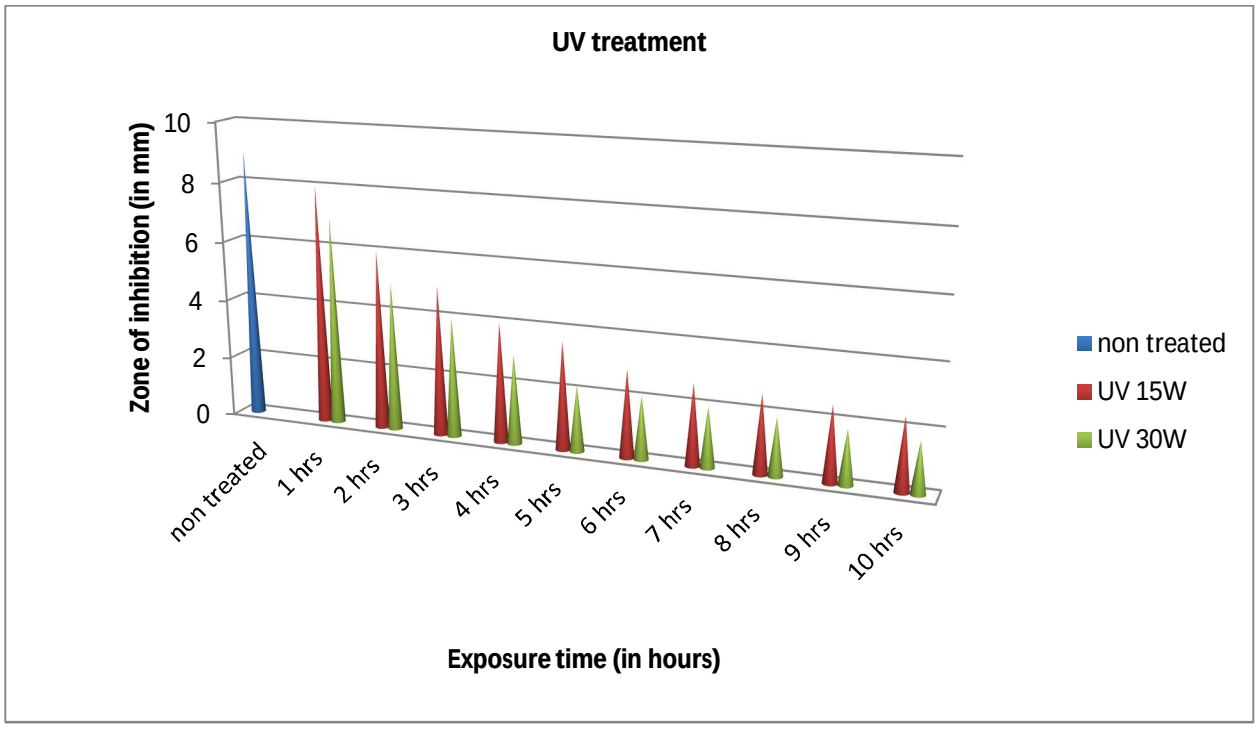

Fig 1: 50 ppm concentration of ampicillin showing UV degradation.

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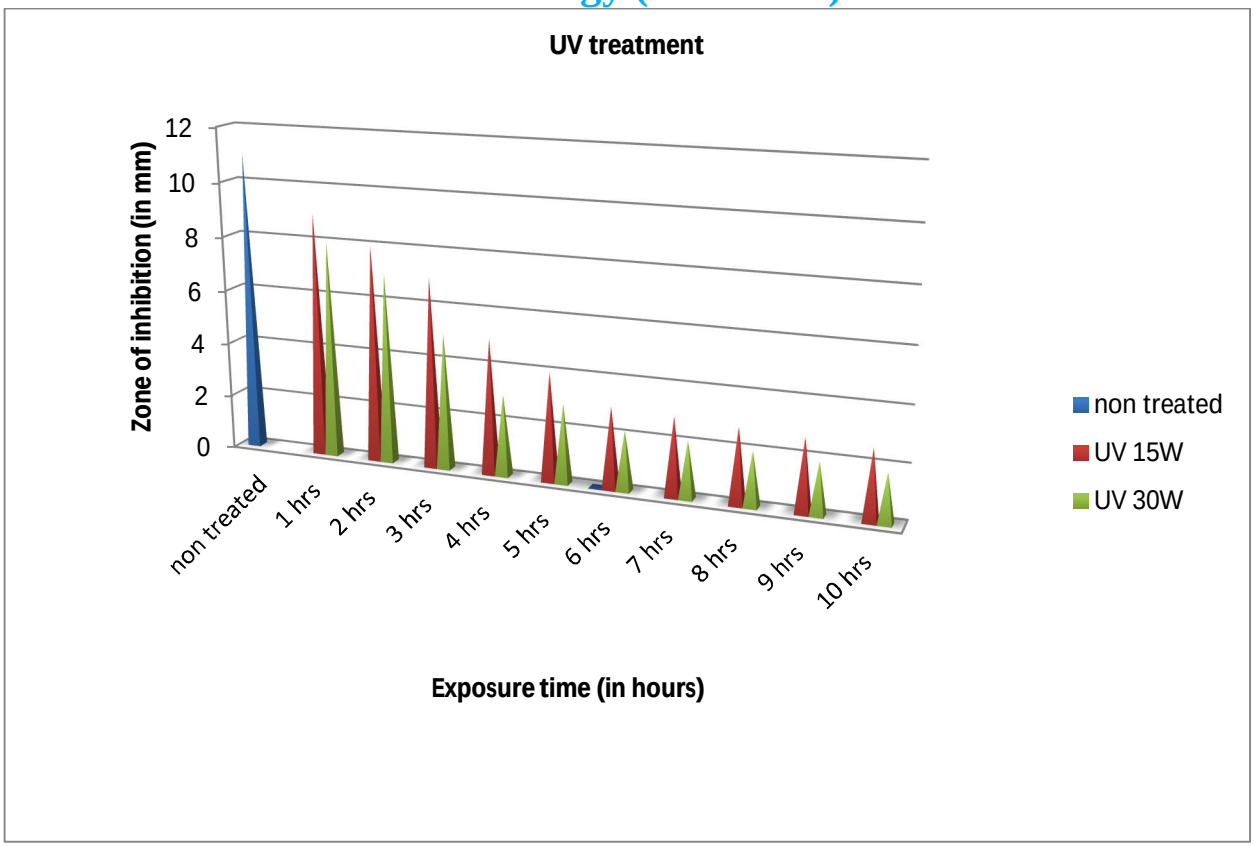

Fig2: 100ppm concentration of ampicillin showing UV degradation.

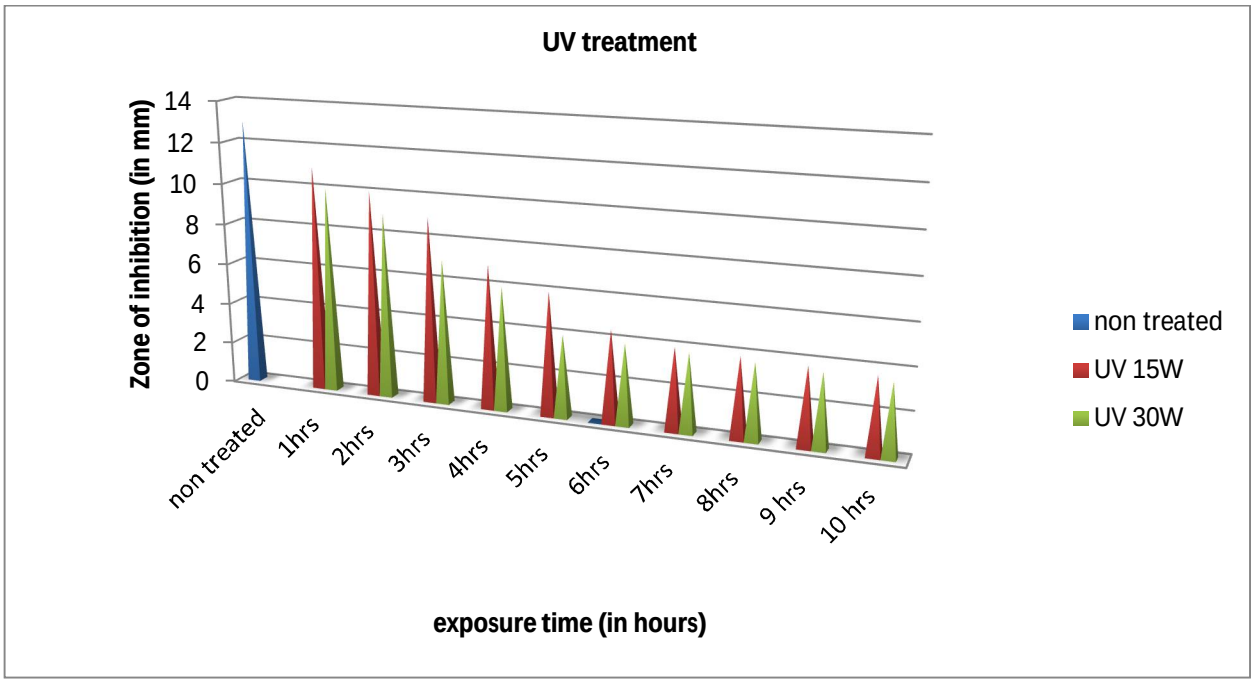

Fig 3: 200ppm concentration of ampicillin showing UV degradation.

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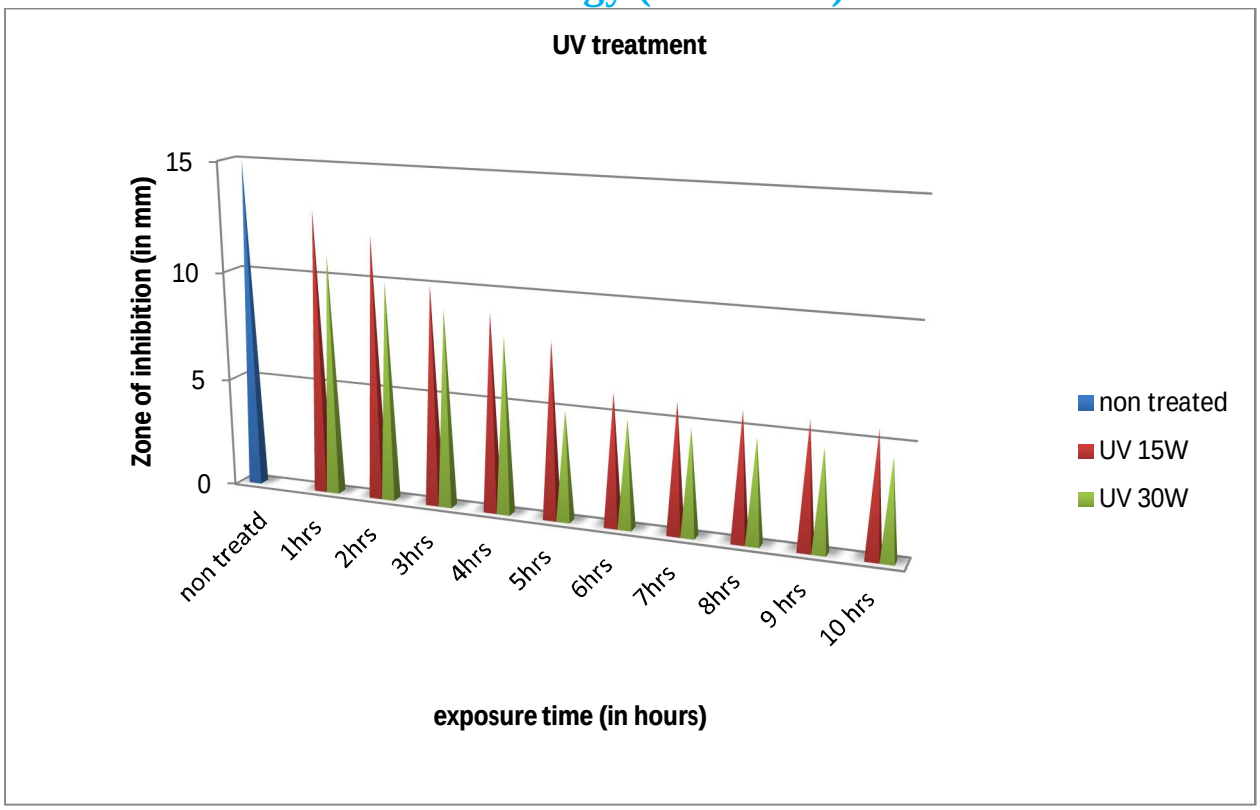

Fig4: 300ppm concentration of ampicillin showing UV degradation.

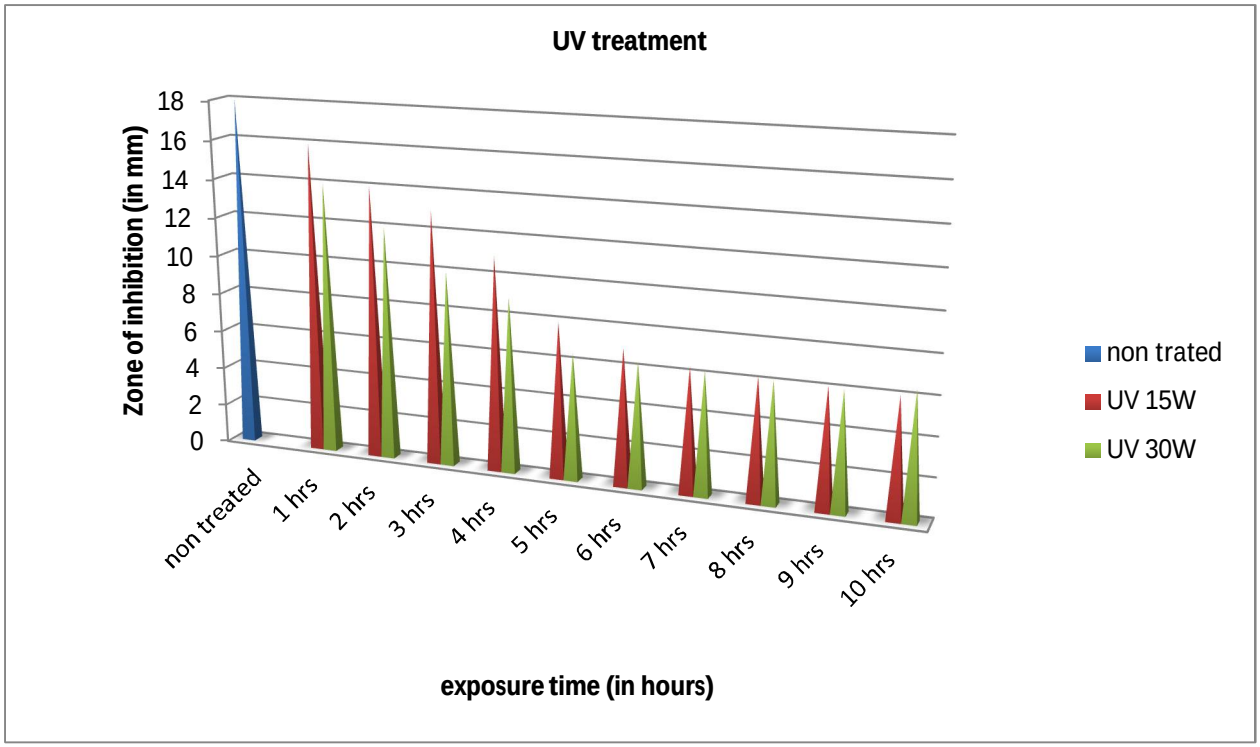

Fig 5: 400ppm concentration of ampicillin showing UV degradation.

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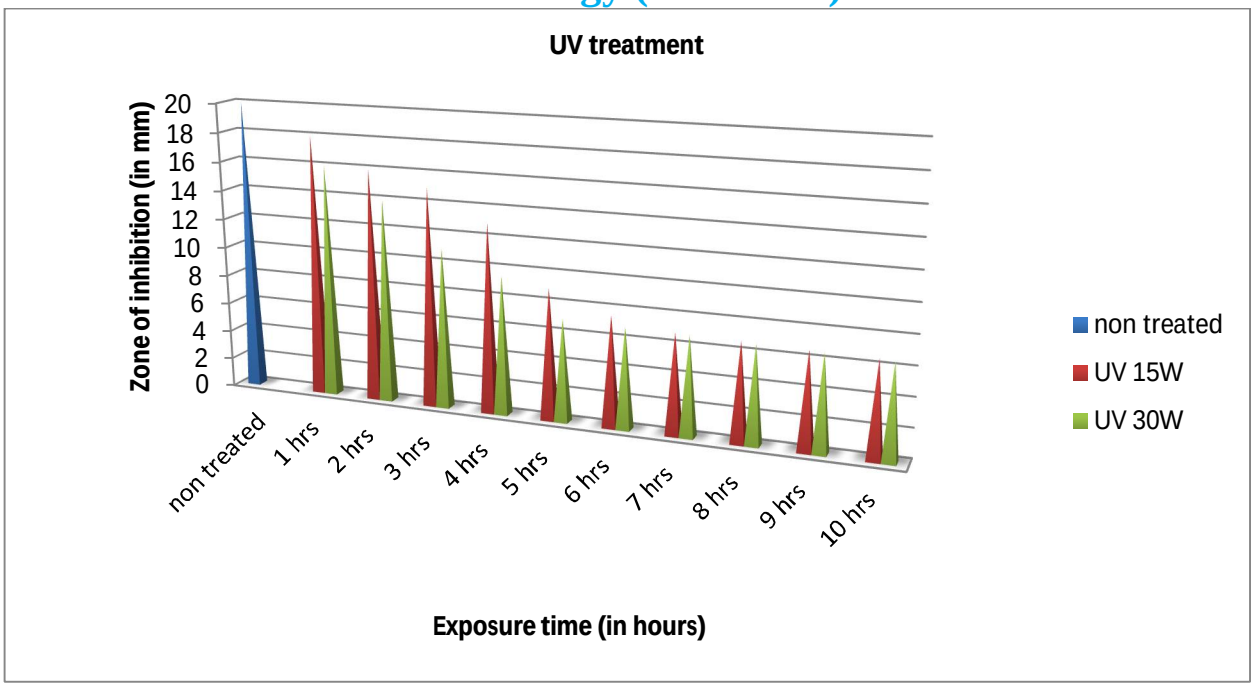

Fig 6: 500ppm concentration of ampicillin showing UV degradation.

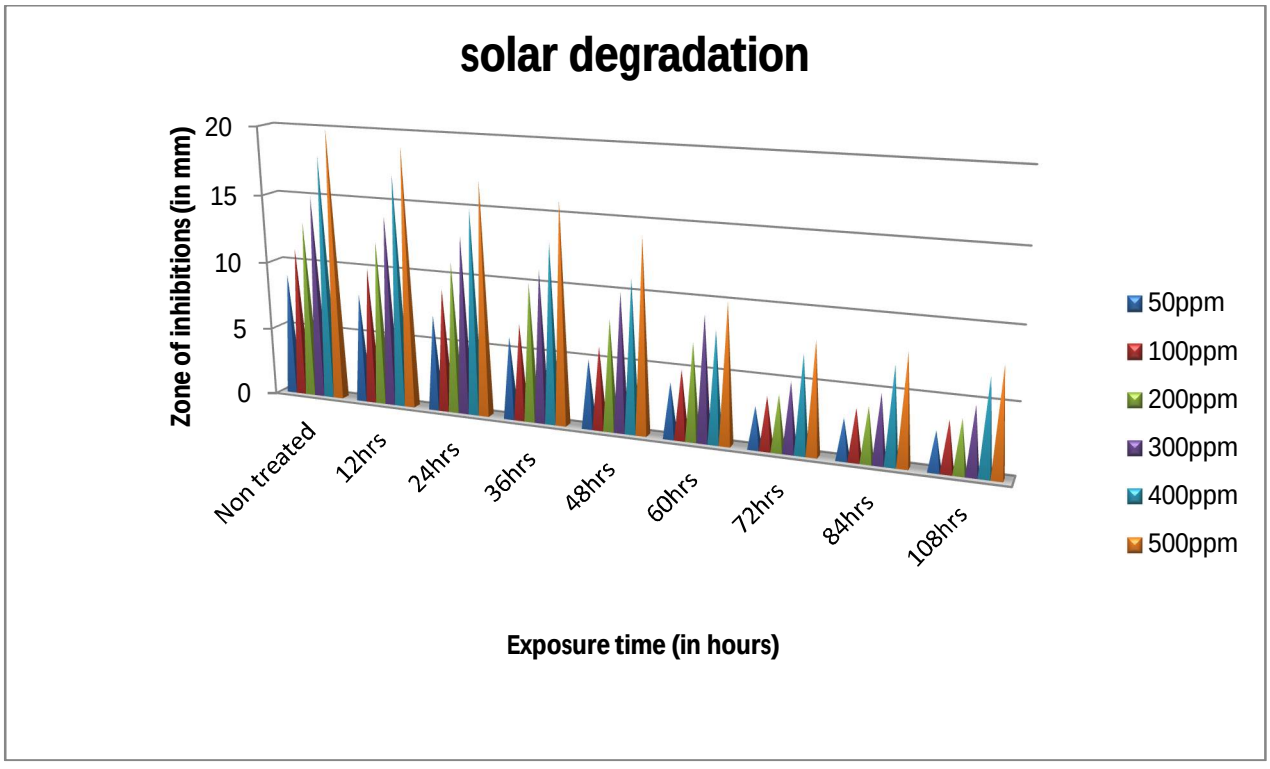

Fig 7: Ampicillin showing degradation with sun light treatment.

IV. CONCLUSION

The semi synthetic antibiotic ampicillin is affective against the harmful bacteria but it is also a killing agent of useful bacteria. When this antibiotic is released untreated in the soil through nursing home and hospital garbage then it causes the soil as well as water

pollution. For the remediation of such pollutant, the soar and UV exposure were studied. The UV exposure was more effective than the solar exposure. The optimum degradation was observed after 5 hrs. of 30 W UV exposure. The maximum solar degradation of ampicillin was noticed after 72 hrs. of exposure.

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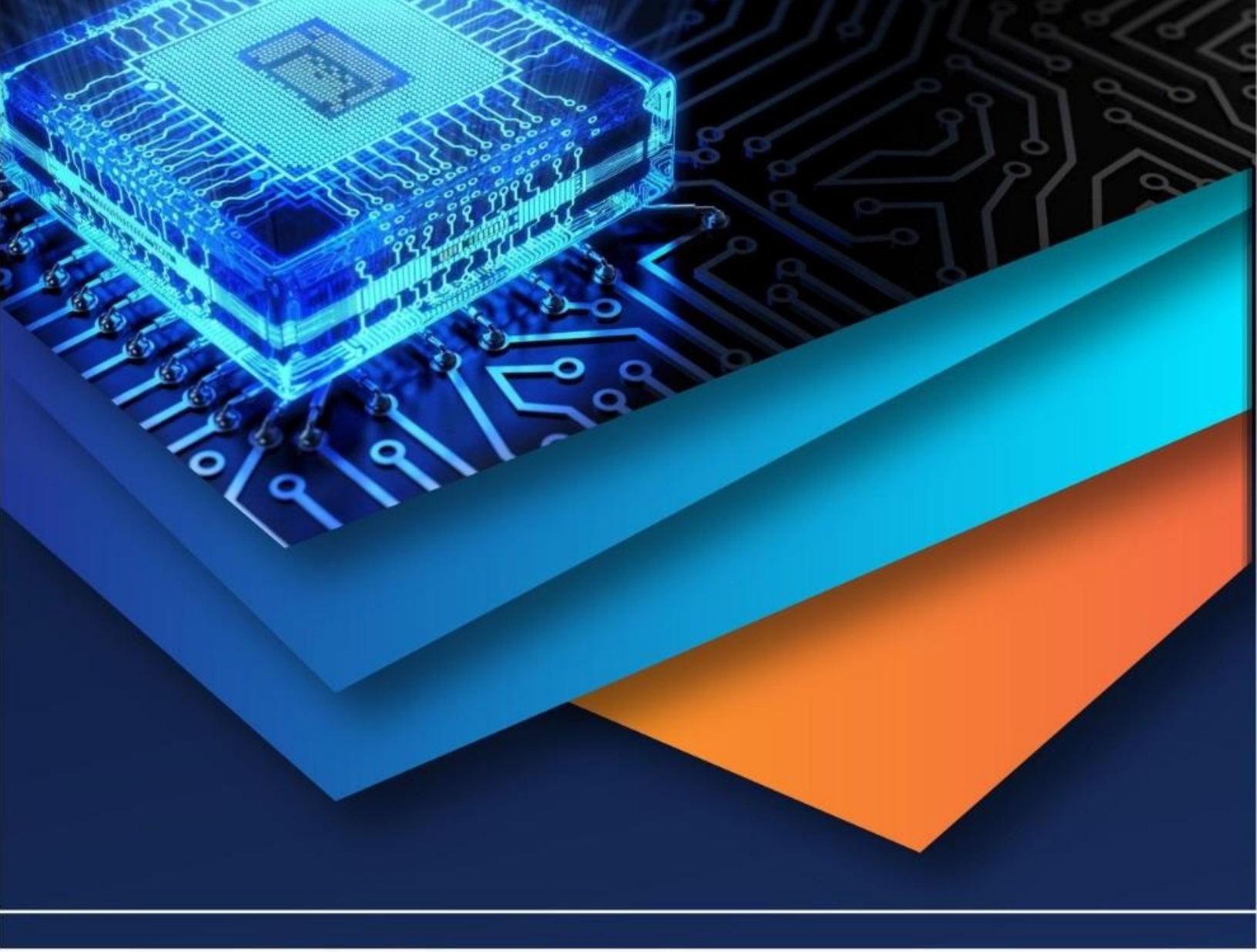

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