Available online at www.pelagiaresearchlibrary.com

Pelagia Research Library

Advances in Applied Science Research, 2011, 2 (2): 315-320

ISSN: 0976-8610
CODEN (USA): AASRFC

A study of the growth of *Allium Cepa* under some Photocatalytic Conditions

Mayank R. Mehta [1], Noopur Goyal [2] and *Vipul P.Prajapati[3]

[1]*Shri P. H. G. Muni. Arts and Science College, Kalol(Gujarat)*
[2]*M. G. Science Institute, Ahemdabad(Gujarat)*
[3]*Sheth M. N. Science College, Patan(Gujarat), INDIA*

ABSTRACT

Aqueous solutions of various dyes were treated photo catalytically using ZnO as semi conductor. Various parameters like pH, concentration of ZnO and concentration of dyes were standardized in terms of minimum time required for bleaching of coloured solutions. This treated water was used to grow plants like onion (Allium cepa) and the growth of plant was studied under such photo catalytic conditions. Influence of this photo catalytic conditions on the biochemical parameters like-Sugar, protein and chlorophyll contents were also observed.

Key words: Dye, Photo catalytic treatment, biochemical parameters.

INTRODUCTION

Water is one of the fundamental requirements of life and any undesired addition of chemical substances leads to its contamination and makes it unfit for human utility. Generally, various dyes found in industrial effluents, ultimately, enter the aquatic ecosystem and can create various environmental hazards. These have very adverse and sometimes irreversible effects on other animals and plants as well. The main purpose of wastewater treatment is the removal of these toxic substances and colour and try to make the water usable for industrial or domestic use. There are various methods used like adsorption, osmosis, flocculation, etc. which have been used traditionally to remove these dyes from the water bodies, but these methods suffer some drawbacks.

The photocatalytic bleaching was found to be the most promising and efficient process in dealing with environmental pollution, wastewater treatment, etc., in which the semiconductor particles act as photo catalysts or short-circuited micro-electrodes on excitation. This method involves the generation of hydroxyl radicals and use of these radicals as the primary oxidant for degrading organic pollutants. The photocatalytic degradation of textile azo dye Sirius Gelb GC on TiO_2 or Ag-TiO_2 particles in the absence and presence of UV- irradiation effect has been reported by Ozkan *et al.*[1] Ameta *et al.* [2] reported photobleaching of basic blue 24using photocatalyst and also studied the role of surfactant in this photo bleaching reaction. Mu Y*et al.* [3] performed the photo catalytic degradation of orange II in presence of Mn^{2+}. Daneshwar *et al.* [4] conducted the photocatalytic degradation of azo dye acid red 14 in water on ZnO as an alternative catalyst to TiO_2. Maruthamuthu *et al.* [5] assessed the photo catalytic activity of Bi_2O_3, WO_3 and Fe_2O_3 selecting photodecomposition of peroxo mono sulphate in visible radiations as the model. Ranjit *et al.* [6] used Fe_2O_3 and ZrO_2-Fe_2O_3 coupled photo catalyst for photo catalytic reduction of nitrite and nitrate ions to ammonia. Baxi[7] has reported the photo catalytic oxidation of oxalic, malonic, succinic, glutaric and adipic acids over semiconducting iron(III) oxide powder. Use of semi conducting iron(III) oxide in photocatalytic bleaching of some dyes were studid by Ameta *et al.* [8]. where as, photocatalytic degradation of methylene blue by CNT/TiO2 composites prepared from MWCNT and titanium n-butoxide with benzene was observed by M.L. Chen *et al.*[9].

MATERIALS AND METHODS

Materials- All the chemicals are of analytical grade and used as received. Stock solutions of various dyes were prepared in doubly distilled water.

Methods- Part-I Photo catalytic Bleaching of Dye-
Various dyes (acidic and basic) were used in the present investigation. All the solutions were prepared in doubly distilled water. The dye solution and ZnO as a semiconductor, were mixed in a 100 ml beaker.Irradiation was carried out keeping the whole assembly exposed to the sunlight. The intensity of light was measured with the help of a solari meter (SM CEL 201). A water filter was used to cut out thermal radiations. The digital pH meter (Systronic Model 335) was used to measure the pH of the solution.

RESULTS AND DISCUSSION

The photocatalytic degradation of the Brilliant Green, Fuchsin Basic, Fuchsin Acidic, Rose Bengal, Toluidin Blue, Methylene Blue, Malachite Gree, Eosine Yellow, Congo Red, Nigrosine dyes were observed at λ max = 611, 544, 522, 544, 665, 664, 616, 515, 488 and 570 nm respectively. It was observed that the absorbance of the dye solutions in presence of semiconductor was much low as compared to sample without semiconductor at the same time intervals. It means that the rate of this photocatalytic degradation is favourably affected by zinc oxide in the case of this system.

Effect of pH
The pH of the solution is likely to affect the bleaching of the dye and hence, the effect of pH on the rate of bleaching of dye solutions was investigated in the pH range as shown into the table-1.

Table-1

No	Dye	Optimum pH of the solution	Amount of ZnO in gm
1	Brilliant green	7.2	0.010
2	Fuchsin Basic	9.2	0.020
3	Fuchsin cidic	10.0	0.030
4	Rose Bengal	10.1	0.030
5	Toluidin Blue	10.3	0.030

It has been observed that the rate of photocatalytic bleaching of these dyes increase on increasing the pH in the alkaline range. This can be explained on the basis that as the pH of the medium is increased, there is a corresponding increase in the concentration of OH^- ions. These OH^- ions will adsorb on the surface of the semi conducting zinc oxide, making it negatively charged. Thus, there will be a coulombic attraction between semiconductor surface and cationic dyes. This results in an increase of rate of photo bleaching of all the dye on increasing pH.

Effect of dye concentration

The effect of dye concentration was also observed by taking different concentrations of the dyes. The rate of photocatalytic bleaching of dyes was found to increase on increasing the concentration.

It may be due to the fact that as the concentration of dye was increased, more dye molecules were available for excitation and consecutive energy transfer. As a result, increase in the rate of bleaching was observed. The rate of photocatalytic bleaching was found to decrease with further increase in the concentration of the dyes, i.e. above their corresponding limits. This decrease may be attributed to the fact that the dye itself will start acting as a filter for the incident light. It will not permit the desired intensity of light to reach the semiconducting zinc oxide particles; thus, decreasing the rate of photocatalytic bleaching of the dyes.

Mechanism

On the basis of these observations, a tentative mechanism for photo catalytic bleaching of dyes may be proposed as – Dye absorbs radiations of suitable wavelength and is excited to its higher energy state.

$$\mathbf{Dye} \xrightarrow{h\nu} \mathbf{Dye^*}$$

$$\mathbf{SC} \xrightarrow{h\nu} \mathbf{e^- (CB) + h^+ (VB) \text{ or } SC^+}$$

$$\mathbf{h^+ + OH^-} \rightarrow \mathbf{OH^*}$$

$$\mathbf{Dye^* + {}^*OH} \rightarrow \mathbf{Leuco\ [Dye]}$$

$$\mathbf{Leuco\ [Dye]} \rightarrow \mathbf{Products}$$

Photo induced electron transfer reactions have attracted the attention of photo chemists all over the world because these reactions are capable of converting toxic compounds into non-toxic or less toxic materials. The photo catalytic bleaching of dye using low cost semi conducting powder like zinc oxide may open new avenues for the treatment of waste water from dyeing, printing and textile industries. Not only this, the treated wastewater may be used for cooling, cleaning, waste land irrigation, etc., which is not possible otherwise with coloured water. Time is not far-off, when photo catalytic route will be firm footed as a promising technology in wastewater treatment.

Part-II Effect of Photocatalytically treated dye water on the growth of Allium Cepa

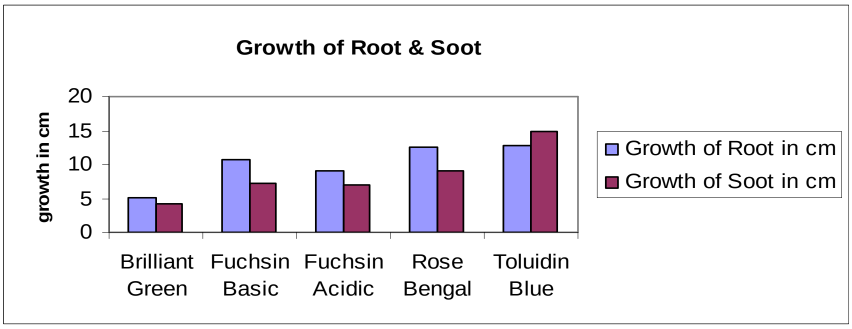
Effect of treated and untreated dye solutions on growth of Allium Cepa was observed and the effect on some biochemical parameters was also studied [10]. Sugar, protein and chlorophyll contents were estimated by established methods. The obtained data are summarized in the following table-2 and comparative study of these is graphically repented in the following graphs.

RESULTS AND DISCUSSION

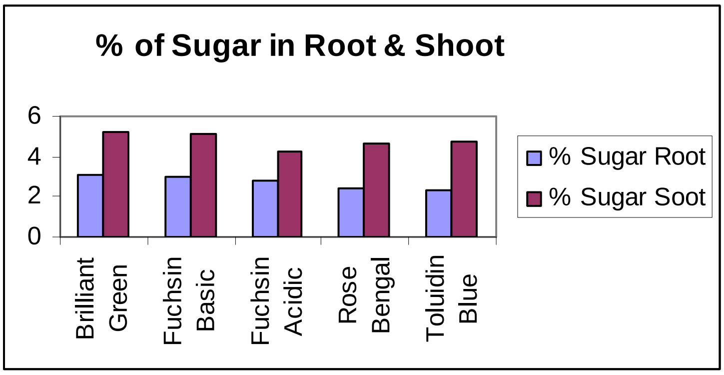
Table-2

No	Dyes	Growth of Root in cm	Growth of Shoot in cm	% Sugar Root	% Sugar Shoot	% Protein Root	% Protein Shoot	Chlorophyll a (mg/g tissue)	Chlorophyll b (mg/g tissue)
1	Brilliant Green	5.1	4.3	3.1	5.2	0.59	0.88	0.66	0.025
2	Fuchsin Basic	10.7	7.3	3.0	5.1	0.42	0.76	0.070	0.065
3	Fuchsin Acidic	9.0	7.0	2.8	4.3	0.38	0.75	0.052	0.048
4	Rose Bengal	12.6	9.0	2.4	4.6	0.42	0.70	0.191	0.080
5	Toluidin Blue	12.8	14.9	2.3	4.7	0.44	0.76	0.105	0.050

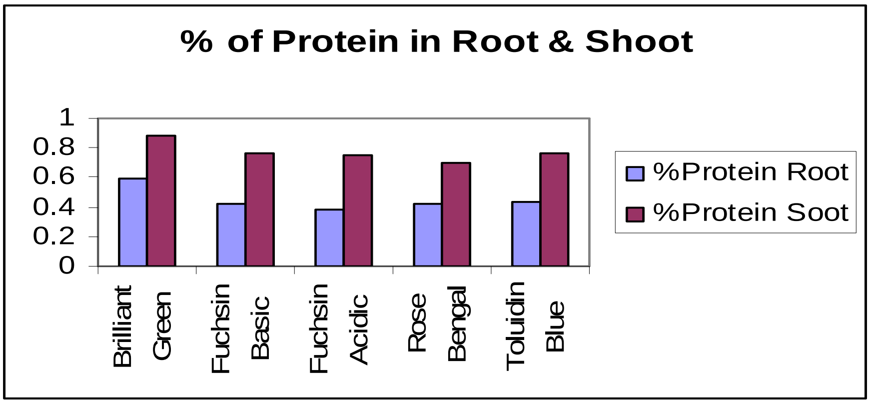
Graph-1



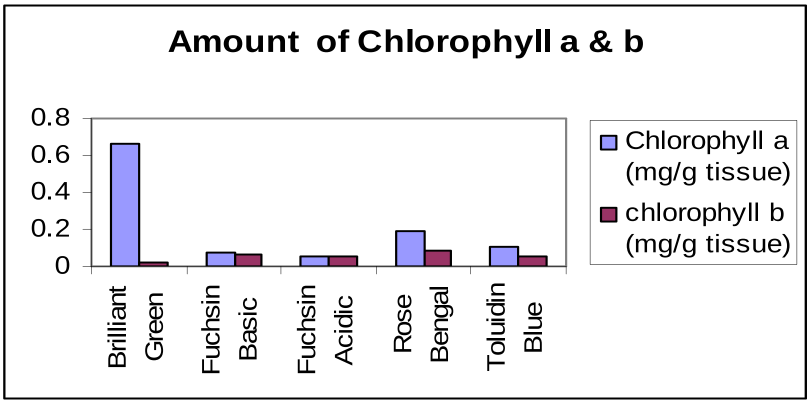
Graph-2



Graph-3



Graph-4



It has been observed that there is a prominent difference in the growth of Allium Cepa grown in different treated and untreated dye solutions and normal water. There was no root or shoot growth in onion grown in dye solution for first few days and after four days, the bulb of onion starts deteriorating where as a prominent root and shoot emerged in onion grown in treated dye solution, these observations suggest that some toxic characteristics [11] are there in dye solution, which inhibits the growth of Allium cepa. When this dye solution was bleached photo catalytically, it loses its toxic nature and this may give normal plant growth. It was also observed that the growth in treated dye solution was more as compared to the growth in normal water. This may be attributed to the fact that nitrogen content in the photo catalytically treated water is increased which supports the growth [12].

Thus the effluent from dyeing industry should be treated before its disposal at outside the industrial area. The waste waters from the dyeing industry will have an adverse effect on growth of Allium cepa but if it is treated and then disposed off, it may restore the quality of water required for normal growth of the plants.

CONCLUSION

It was observed that there was a prominent growth and increased sugar and protein percentage and chlorophyll content in onion grown in photo catalytically treated effluent. Based on the above results, photo catalytic treatment of wastewater can be considered as an effective method, which will help in reusing the effluent from dye industry for irrigation purposes.

Acknowledgements
The authors are thankful to the UGC, WRO, Poone for the financial assistance and to the Principal, Shri P. H. G. Muni. Arts and Science College, Kalol-382721(Gujarat) for his kin cooperation. We also thankful to Prof. S. C. Ameta, Former head, Deptt. Of Chem., M. L. Sukhadia University, Udaipur, Rajasthan, India for the valuable guidance.

REFRENCES

[1] Ozkan A, Ozkan M H, Gurkan R, Akcay M & Sokmen M, *J Photochem Photobiol*, **2004**,163A,29.
[2] Ameta R, Kumari C, Bhatt C V & Ameta S C, *Ind Quim*, **1998,**33,36.
[3] Mu Y, Zheng J C & Zhang S J, *J Photochem Photobiol*, **2004,**163A, 311.
[4] Daneshwar N, Salari D & Khatare A R, *J Photochem Photobiol*, **2004**,162A, 317.
[5] Maruthamuthu P, Gurunathan K, Subramanian E & Ashok Kumar M, *Bull Chem Soc Japan*,**1991**, 64A, 1993.
[6] Ranjit K T, Varadrajan T K & Vishwanathan B, *Indian J Chem*, **1996**,35A, 177.
[7] Baxi V, Ph. D.Thesis, Mohanlal Sukhadia University, Rajasthan, India, **2004**.
[8] Ameta Rajat , Vardia Jitendra, Punjabi Pinki B. & Ameta Suresh C., *Indian Journal of Chemical Technology*, **2006,**13,114-118.
[9] M. L. Chen, F. J. Zhang, and W.C.Oh, Journal of the Korean Ceramic Society, **2008,** 45(11), 651–657.
[10] Ameta Suresh C, Punjabi Pinki Bala, Kothari Shilpa, Sancheti Anjali, *Polln Res*, **2003,**22(3), 389-392.
[11] N Puvaneswari, J Muthukrishnan & P Gunasekaran, *Indian Journal of Experimental Biology*, **2006**, 44, 618-626.
[12] Chunxiang Li A1, Pengwei Huo A2, Songtian Li A3, Yongsheng Yan A4 , *International Journal of Materials and Product Technology*, **2010,** 39(3-4), 330–338.