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Effect of the flowers of *Moringa oleifera* during electrochemical treatment of dye waste water

SARU GUPTA, P.S. VERMA and P.P. BAKRE*

Department of Chemistry, I.G.C. For HEEPS*, University of Rajasthan, Jaipur (India).

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ABSTRACT

The effectiveness of the use of the flowers of *Moringa oleifera* in the electrochemical treatment and reuse of the dye wastewater, which was collected from various dyeing units of Sanganer area, was studied using stainless steel electrodes in the presence of NaCl electrolyte and current density of 3mA/cm^2. A substantial reduction in TDS, BOD, COD and heavy metals as compared to the original dye wastewater sample was observed. The efficacy of the treatment has been tested by observing the survival rate of *Gambusia affinis* and *Lymnaea acuminata* in the electrochemically treated wastewater, *Moringa oleifera* treated dye wastewater and the original dye wastewater effluent.

Key words: Electrochemical treatment, parameters, dye wastewater, *Moringa oleifera, Gambusia affinis, Lymnaea acuminata.*

INTRODUCTION

The textile industry, has acquired attention by the environmentalists due to the water consumption and wastewater generation. The dye industries on an average consume about 100 litres of water to process about 1 Kg of textile materials. The wastewater discharged is characterized by a high pH, TDS, BOD, COD and heavy metals. The color concentration in discharged effluent from textile, leather, paper, petroleum, chemical tannery etc. industries varies from 200µg/l to 1000µg/l. The wastewater is discharged into the nearby water bodies as a result of which hazardous components are also introduced at various trophic levels through the food chain, which then undergo bioaccumulation and biomagnification. It leads to various diseases in aquatic species and other organisms coming in contact. Thus, the discharged dye wastewater seriously endangers the environment. The heavy metals, typically, Fe, Cu, Zn, Cr etc., are very hazardous to human and aquatic life at relatively low concentration. They are introduced in the wastewater of textile dye industry through the use of premetalised dyes and heavy metal afterwashes which are used to increase the light fastness of the finished product.

Khan *et al.,*(1995) have studied the effects of industrial effluents on physico-chemical characteristics of the Amanishah Nallah, near Sanganer. Nanda *et al.,* (2000) exposed the air breathing fish to paper mill effluent to study the toxicity level. The 96 hr LC30 values was found to be 6.09%, 80.35%, and 81.28% in *Anabas testudineus*, *Channa punctatus* and *Clarius batrachus* respectively.

The removal of dyes in an economic fashion still remains an important problem and a number of studies have been done for the same. Brown *et al.,* (2004) used Nylex 100 as an adsorbent

material for the treatment of dye house effluent using anodic oxidation regeneration. Inazaki *et al.,*(2004) have investigated the effects of the electrolytic treatment in the simulated wastewater with aromatic amine n-phenyl-n-isopropyl-p-phenylenediamine (Flexzone3P®) using Ti/Ti-RuO_2 electrodes under 0.025A/cm^2 for different electrolysis durations (5, 15, 30, 45, 60 min.). Muthukumar *et al.,*(2004) have investigated the treatment of textile dye wastewater by using electrochemical bipolar disc stack reactor using RuO_2/Ti as anode and Ti as cathode. Panizza and Cerisola (2004) have studied the electrochemical oxidation of synthetic tannery wastewater using Ti/PbO_2 and Ti/RuO_2 as anodes under different experimental conditions.

Chen *et al.,*(2005) have studied the reduction in TSS, COD and turbidity using electrochemical oxidation and membrane filtration. Panizza *et al.,*(2005) considered electrochemical oxidation as an effective method for colour removal; there was little or no consumption of chemicals, no sludge production and degradation of recalcitrant pollutants could be achieved, including polyaromatic organic compounds like anthraquinone based compounds.

Vaghela *et al.,*(2005) have studied the reduction in COD and removal of color by the electrochemical treatment of azo dye effluent.

Asilian, H. *et al.,*(2006) removed acrylic water base colour from synthetic wastewater using coagulation with $FeSO_4$, alum, lime and polyelectrolyte. The obtained results showed that treatment with alum and $FeSO_4$ alone prove to be very effective in removing colour (>99%) and part of COD (60-70%) from aqueous solution.

Fongstatikul *et al.,*(2006) explored the effectiveness of an electrochemical process to treat a sulphur dye wastewater using fine steel electrode plates. Results indicated that COD, TSS removal efficiency improved with a decrease in initial pH and increase in electrical charge.

In the present investigations, various parameters like TDS, TSS, BOD, COD, concentration of NO^-_3, SO_4^{2-} and some heavy metals have been determined in the dye effluent and then the electrochemical treatment of the dye effluent is performed using suitable electrodes and current conditions.

The present study is focused on the optimization of the electrochemical decolourisation and detoxification of the textile effluents containing reactive dyes with the aim of making this method feasible –technically and economically, at industrial scale.

MATERIAL AND METHODS

The dye wastewater samples were collected from various dyeing industries nearby Jaipur. The samples were analysed for various parameters like pH, TDS, BOD (27°C, 3d), COD, and heavy metals. AAS technique was employed for the determination of concentration of heavy metals. The same samples were now treated electrochemically. Rectangular plates of stainless steel (SS316) were used as cathode as well as anode. Electrodes of area 4cm X 2.5 cm were immersed in the dye effluent and the electrodes were separated by a distance of 3-4 cm respectively. A Remi (2LH model) hot plate cum magnetic stirrer was used throughout the electrolysis process. A glass beaker of 1000ml capacity was used as electrolysis vessel. Electrolysis was carried out for 45 minutes. The current density was 3mA/cm^2 throughout the electrolysis and 2 gm NaCl was added to the wastewater effluent. The electrolytic solution was stirred with the help of magnetic stirrer. The dye begins to precipitate and forms a loose sludge which is initially formed at the top of the mother liquor and eventually settles down at the bottom of the reaction vessel. After electrolysis the experimental electrolytic solution is filtered. The filtrate obtained was colorless and was tested for TDS, pH, BOD (27°C, 3d), COD and concentration of heavy metals.

In the second phase of the study, 2 grams of shade dried and powdered flowers of *Moringa oleifera* was added to one litre of dye wastewater effluent and electrochemical treatment was done using stainless steel 316 electrodes at a current density of 3mA/cm^2. 2g NaCl was added and electrolysis was carried for 45 minutes. A Remi (2LH model) hot plate cum magnetic stirrer was used

throughout the electrolysis process. After electrolysis the experimental electrolytic solution is filtered. The various parameters like pH, TDS, BOD, COD and heavy metal concentration were analysed again for the filtrate.

In the third phase of the study, ten each of *Gambusia affinis* and *Lymnaea acuminata* were introduced in the dye wastewater effluent, electrochemically treated sample and natural purifier treated sample .These water samples were 100%, 75%, 50%, 25% concentrated samples .

RESULTS AND DISCUSSION

The various parameters analysed for original dye wastewater sample (OS), electrochemically treated sample (ET) and *Moringa oleifera* treated sample (ET-NP) are listed in Table 1.

The pH of ET decreased to 6.69 from 10.46 for OS. The pH lies within the safe limits for ground waters. TDS showed a large decrease in ET by 98.4% as compared to OS. BOD and COD showed a large decrease by 99.8% and 79% respectively in the ET as compared to OS. The concentration of Cu, Fe and Zn reduced drastically. Fe and Zn were observed to be negligible in ET after treatment. Cu was reduced by 73% after electrochemical treatment. The above results clearly indicate the efficiency of electrochemical treatment of dye waste water.

The pH was found to decrease to 7.62 in ET-NP as compared to the highly basic nature indicated by the pH of 10.46 for OS. The TDS decreased to a large extent by 98% in ET-NP as compared to OS. BOD and COD for ET-NP were found to be negligible, which clearly shows the effectiveness of the treatment for purifying dye wastewater. The concentration of Cu and Zn were found to decrease by 50.6% and 9% in ET-NP as compared to OS. Thus, flowers of *M. oleifera* have proved to be effective for electrochemical treatment of dye wastewater when the sample was highly basic.

In the third phase of the study, 10 *Gambusia affinis* and 10 *L. acuminata* were introduced in the OS, ET and ET-NP, which each time were 100%, 75%, 50%, 25% concentrated samples . The results are reported in Table 2.

It was observed that no fish could survive for more than 1.5 hours in 100%, 75%, 50% concentrated samples. However 30% of the fish survived for 24hs in 25% concentrated sample and 10% of the fish only could survive for the next 24 hours. No fish was observed to survive after 48 h.

Table 1.

S. No.	Parameters	OS	ET	ET-NP
1	pH	10.46	6.69	7.62
2	TDS(g/L)	5.216	0.0834	0.0952
3	BOD(mg/L)	296	0.65	Negligible
4	COD(mg/L)	150	32	Negligible
5	Cu(ppm)	0.089	0.024	0.044
6	Fe(ppm)	0.6751	Nil	0.7162
7	Zn(ppm)	3.614	Nil	0.325
8	Colour	Dark Brown	colourless	Light yellow

Area : Area beyond Sanganer
OS: Original sample of dye effluent
ET: Electrochemically treated sample of dye effluent
ET-NP: Electrochemically treated with flowers of *Moringa oleifera* as natural purifier

Table 2: OS: Original sample of dye effluent

%Concentrated Sample	Time	No. of *G. affinis* survived			No. of *L. acuminata* survived		
	(hrs.)	OS	ET	ET-NP	OS	ET	ET-NP
100	24	0	10	10	0	10	10
	48	0	10	10	0	5	10
	72	0	10	10	0	5	10
	96	0	10	10	0	5	10
75	24	0	10	10	0	10	10
	48	0	10	10	0	10	10
	72	0	10	10	0	5	10
	96	0	10	10	0	5	10
50	24	0	10	10	0	10	10
	48	0	10	10	0	10	10
	72	0	10	10	0	10	10
	96	0	10	10	0	10	10
25	24	3	10	10	1	10	10
	48	1	10	10	0	10	10
	72	0	10	10	0	10	10
	96	0	10	10	0	10	10

ET: Electrochemically treated sample of dye effluent
ET-NP: Electrochemically treated with flowers of *Moringa oleifera* as natural purifier

In the electrochemically treated effluent, 100% fish could survive in all concentrations of the sample. So, the effectiveness of the electrochemically treated sample can be well established.

The dye effluent was further tested for its capacity of animals to survive in it by introducing *Lymnaea acuminata* in it. Ten *Lymnaea acuminata* were introduced in the effluent, which each time was having different concentrations.100%, 75%, 50%, 25% concentrated samples were used. Only 10% of the *Lymnaea acuminata* could survive in 25% diluted effluent for 24 hours only. Thereafter no animal survived in such a diluted sample.

Ten *Lymnaea acuminata* were introduced in the electrochemically treated effluent. When the effluent was totally undiluted i.e., 100% concentrated, 100% of the animals survived for 24 hours but only 50% were seen alive after that for 96 hours and beyond.

When sample was 25% diluted, 100% of the mollusca survived up to 48 hours. Thereafter, 50% of the animals survived for 96 hours and beyond. For 50% and 25% concentrated samples of the electrochemically treated effluent, 100% of the animals survived for 96 hours and beyond.

To test the efficacy of water treated using the flowers of *Moringa oleifera*, ten *G. affinis* and *Lymnaea acuminata* were introduced in the ET-NP sample.

It was observed that all the animals survived for 96 hours and beyond in all concentrations of the sample treated with *M. oleifera* flowers.

CONCLUSION

The electrochemically treated sample showed a decrease in pH, TDS, BOD, COD, heavy metal concentration. The dark brown coloured

sample was rendered colourless. Thus, the electrochemically treated water is better than the effluent sample. Further the treatment with the flowers of *Moringa oleifera* also showed a decrease in pH, TDS, BOD, COD, Cu and Zn as compared to the original sample. The concentration of Fe was slightly increased but well within the same limits. The survival rate of *Gambusia affinis* and *Lymnaea acuminata* was found to be 100% at all concentrations in the natural purifier treated dye wastewater sample. This clearly establishes the role of the flowers of *Moringa oleifera* as a natural purifier.

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