# Assessment and Phytoremediation Studies of Yamuna River using *Eichhornia crassipes*

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***Abstract*-Water pollution is the major source of environmental degradation. Industrialization and wide range of human activities have demanded for good quality water while pollution has increased day by day. Yamuna River is the most important river of India originating from Himalaya. The status of Yamuna River water is very much useful as it determines physiological life cycle of plants, animals and human beings. Yamuna River is most polluted river in north India. It's water flow from Bandar Punch, Yamuna Nagar, Sonepat, Delhi, Gautam Buddh Nagar, Faridabad, Palwal, Aligarh, Mathura and Agra. In this study water samples were collected from three different sites of Yamuna River at Agra such as Kailash Temple, Poiya Ghat, Taj Mahal. The plant used for this study is *Eichhornia crassipes* and grown in contaminated Yamuna water with three different concentrations of EDTA. The concentration of 1mg/l, 10 mg/l, and 100 mg/l were used in three replications for each concentration. The result shows that EDTA decreased the physicochemical parameters viz. pH, Electrical conductivity, TDS, Total hardness, Total Alkalinity, BOD, COD and increased the level of dissolved oxygen in all three sites.**

**Key words: EDTA, Physicochemical parameters, Pollution, Yamuna River**

## INTRODUCTION

The environmental pollution is a major problem in the global context. Rapid urbanization and industrialization has led to increased disposal of pollutants in to the environment. During pollution, the pollutant originating from the source get spread in to water, air and soil which causes water, air and soil pollution. Industrial waste, domestic waste and agricultural activities are the major sources of water pollution. Yamuna is a famous river and also symbol of our prosperity, our culture, civilization and our philosophy.

In Agra the Yamuna River has always been the most important freshwater resources. However, Yamuna water is used in every sector of development like agriculture, industry, transportation, public water supply etc. Huge load of wastewater from industries, domestic sewage and agricultural practices find their way in to Yamuna, resulting in large scale deterioration of the water quality and affect the physicochemical parameters of water. Different types of industries like sugar, fertilizer, cement, fermentation, thermal power, caustic soda, oil refineries, pulp, paper, dye, pesticides and pharmaceutical etc. are the major sources of pollution in Yamuna River. The pulp and paper mills generate the maximum amount of pollution at the pulping, pulp washing and pulp bleaching stage. In sulphate and soda pulping, where chemicals are not recovered, black liquor in wastewater is the major contribution factor towards pollution. Wastewater from bleaching operation contains high BOD and dissolved organic and inorganic materials.

Phytoremediation is a process used by plants to degrade or accumulate harmful substances that are found in ecosystem. [1],[2],[3]. Native plants and trees that have great potential to purify contaminated water were studied by Panday and Mishra [4]. Aquatic plants have been effectively used to reduce pollution level in relative reduction of BOD, COD, total alkalinity, total hardness, TDS and metal from industrial wastewater. Some examples of aquatic plants used for phytoremediation are *Lemna* spp, *Vallisnaria* spp, *Ceratophyllum* spp, *Potamogeton* spp, *Sagittaria* spp etc. For this study *Eichhornia crassipes* is taken because of their easy availability fast growth rate and large uptake of nutrients and contaminants.

## MATERIALS AND METHODS

Collection and analyses of water sample; Samples were collected from three different sites of Yamuna River at Agra in the summer season during 2022.

SITE 1- Kailash Temple
SITE 2- Poiya ghat
SITE 3- Taj Mahal
Water sample were collected in a plastic bottle at freezing temperature (6-8ºc) and transported to the laboratory for analysis of physicochemical parameters.The physicochemical parameters investigated in this study include pH, electrical conductivity, TDS, total hardness, total alkalinity, DO, BOD, COD.(Table-1)


Fig. 1 Sampling Sites

Plant material: Young plant of aquatic weed *Eichhornia crassipes* (water hyacinth) was collected from Yamuna River. This plant was washed thoroughly with running tap water followed by distilled water to avoid any surface contamination. The plant material was cleaned with bloating paper for any surface moisture avoiding damage to root and leaves. The plant was then grown in the same Yamuna water.

Experimental set up: Experiment was performed in 27 plastic tubs of 5 liters capacity each with three different concentrations of EDTA i.e. 1 mg/l, 10 mg/l, 100 mg/l and 3 tub as control without EDTA in triplicates for 30 days from all sites.

Statistical analysis; Data were expressed as mean and standard deviation.

RESULT AND DISCUSSION

Several chelating agaents, such as EDTA, EGTA (Ethylene glycol tetra acetic acid), EDDS (ethylenediamine disuccinate), NTA and citric acid, have been found to enhance phytoremediation and increase metal accumulation [5],[6]. In present study EDTA has proven effectiveness with phytoremediation application so it is the commonly selected chelator in this study. The result shows that the level of physicochemical parameters of Yamuna water decreased by *Eichhornia crassipes* after EDTA treatment. The concentration of dissolved oxygen was seen to be increased with EDTA than control i.e. without EDTA. The initial concentration of BOD was 21.3 mg/l, 15.3 mg/l, 16 mg/l in site 1, site 2, and site 3 respectively. When 1 mg/l of EDTA was added, the concentration was decreased. It was further decreased with 10 and 100 mg/l of EDTA.

The mean value of initial dissolved oxygen was 3.5 mg/l, 3.6 mg/l, 4.8 mg/l from three respective sites. Without EDTA this value was increased 1.7 mg/l, in control condition and further increased 2.6 mg/l, 2.7 mg/l, 4.3 mg/l with 1 mg/l, 10 mg/l, 100 mg/l 0f EDTA by *Eichhorna crassipes* for 30 days of treatment. It was indicated that greater increase of dissolved oxygen by *Eichhornia crassipes* noticed along with 100 mg/l of EDTA.

Table-1 Initial physicochemical parameters of water samples (n=3, mean±SD) collected from selected site of Yamuna River summer season

| PARAMETERS | SITE 1 | SITE 2 | SITE 3 |
|---|---|---|---|
| pH | 8.4±0.152 | 8.0±0.152 | 7.8±0.1 |
| Electrical Conductivity μs | 1202.6±2.156 | 1223±2 | 1302±4 |
| TDS mg/l | 822±2 | 1043±3 | 1213.3±2.081 |
| Total Alkalinity mg/l | 272.6±2.516 | 301.3±3.511 | 337.6±2.516 |
| Total Hardness mg/l | 298±2 | 329±2.645 | 361.6±2.081 |
| Dissolve oxygen mg/l | 3.5±0.305 | 3.6±0.321 | 4.8±0.208 |
| BOD mg/l | 21.3±1.154 | 15.3±5.033 | 16±2 |
| COD mg/l | 111.6±5.507 | 106.3±5.507 | 95.6±5.507 |

Table-2 Effect of EDTA on physicochemical parameters of treated Yamuna water (n=3, Mean±SD

| TREATMENT | DAYS | pH | EC | TDS | TA | TH | D0 | B0D | COD |
|---|---|---|---|---|---|---|---|---|---|
| SITE 1 | | | | | | | | | |
| CONTROL | 10 | 7.9±0.2 | 1197±1.53 | 784±2.08 | 256±1.52 | 159±4.16 | 5.2±0.1 | 20±1 | 113±3.51 |
| | 20 | 7.6±0.1 | 1099±3 | 660±2 | 194±4.04 | 232±3.05 | 5.6±0.3 | 16±1.52 | 94±3.05 |
| | 30 | 7.4±0.11 | 1023±2.08 | 561±1.52 | 138±2.08 | 188±2.51 | 5.2±0.15 | 13±1.52 | 85±3.05 |
| 1 mg/l EDTA | 10 | 7.7±0.1 | 1106±3.05 | 771±1.52 | 208±2.65 | 251±1 | 5.4±0.4 | 17±1.731 | 109±2.08 |
| | 20 | 7.4±O.1 | 1001±2.08 | 619±0.58 | 180±2.52 | 212±3.05 | 5.7±0.15 | 14±1.52 | 98±2.30 |
| | 30 | 7.3±0.1 | 977±1.5 | 521±1.53 | 101±2.51 | 181±2.08 | 6.1±0.1 | 10±1.52 | 77±1 |
| 10 mg/l EDTA | 10 | 7.8±0.15 | 1138±1.52 | 691±1.52 | 194±2.52 | 205±4 | 5.8±0.1 | 16±1.53 | 98±1 |
| | 20 | 7.6±0.2 | 1085±4.72 | 601±1.52 | 149±2.65 | 176±2.52 | 6.1±0.1 | 13±1.53 | 82±2.51 |
| | 30 | 7.3±0.15 | 824±4.04 | 537±2.08 | 114±2.64 | 118±2.65 | 6.2±0.2 | 12±2.08 | 73±2.65 |
| 100 mg/l EDTA | 10 | 7.8±0.1 | 1034±4.05 | 671±2 | 171±2.64 | 201±2.08 | 6.5±0.49 | 19±1 | 92±2.52 |
| | 20 | 7.4±0.15 | 927±3.60 | 562±2.51 | 138±3.51 | 167±3.6 | 7.3±0.2 | 16±1 | 82±2.08 |
| | 30 | 7.1±0.15 | 799±2.51 | 501±3.21 | 103±4.58 | 122±2.64 | 7.8±0.1 | 10±1.53 | 70±2.51 |
| SITE 2 | | | | | | | | | |
| TREATMENT | DAYS | pH | EC | TDS | TA | TH | D0 | B0D | COD |
| CONTROL | 10 | 7.7±0.1 | 1218±1.53 | 1020±1.53 | 239±3.21 | 318±2 | 4±0.1 | 14±2.08 | 98±1.53 |
| | 20 | 7.5±0.1 | 1185±2.52 | 993±1.52 | 207±2 | 282±4.35 | 4.3±0.15 | 12±2.52 | 90±3 |
| | 30 | 7.3±0.15 | 1023±0.57 | 904±1.52 | 197±2.30 | 251±1 | 4.9±0.21 | 10±1.53 | 81±2.08 |
| 1 mg/l EDTA | 10 | 7.6±0.1 | 1093±3.5 | 1007±3 | 211±3.78 | 249±4.16 | 4.1±0.21 | 13±3.05 | 95±1.52 |
| | 20 | 7.4±0.05 | 988±2 | 978±2.08 | 188±4.04 | 273±2.52 | 4.6±0.31 | 12±2.52 | 80±1.53 |
| | 30 | 7.2±0.1 | 802±1.53 | 822±2.08 | 169±0.04 | 247±2 | 5.2±0.32 | 10±1.53 | 71±1 |
| 10 mg/l EDTA | 10 | 7.6±0.17 | 1081±3.21 | 980±3.51 | 182±3.51 | 280±3 | 4.4±0.26 | 11±2.52 | 94±2.51 |
| | 20 | 7.5±0.1 | 978±2 | 898±4.04 | 159±3.05 | 203±2.51 | 4.9±0.21 | 10±2.08 | 79±2.65 |
| | 30 | 7.2±0.05 | 853±3.05 | 796±4 | 150±2 | 193±2.51 | 5.7±0.20 | 9±1.73 | 75±2.64 |
| 100 mg/l EDTA | 10 | 7.6±0.21 | 1071±2.65 | 906±4.16 | 178±2.52 | 260±2 | 4.5±0.32 | 11±3.51 | 91±2.52 |
| | | 7.4±0.15 | 949±2.52 | 863±3.05 | 155±3.61 | 247±4.16 | 5.3±0.35 | 9±2.08 | 82±2.64 |
| | 30 | 7.0±0.05 | 820±1 | 720±2.52 | 137±3.78 | 182±3.05 | 6.5±0.21 | 9±2.51 | 76±2 |
| SITE 3 | | | | | | | | | |
| TREATMENT | DAYS | pH | EC | TDS | TA | TH | D0 | B0D | COD |
| CONTRL | 10 | 7.6±0.1 | 1292±2 | 1186±2.30 | 291±2.08 | 317±1.52 | 5.7±0.1 | 16±2.64 | 91±2.08 |
| | 20 | 7.5±0.1 | 1252±2.08 | 1121±2.64 | 232±2.51 | 272±2.64 | 5.9±0.15 | 14±2.08 | 73±2.64 |
| | 30 | 7.3±0.1 | 1205±2.64 | 1074±1.52 | 185±1.53 | 249±1.52 | 6±0.15 | 12±1.52 | 63±1.52 |
| 1 mg/l EDTA | 10 | 7.4±0.21 | 1282±2.52 | 1160±2 | 281±1.52 | 300±3.51 | 5.9±0.15 | 15±1 | 84±2.64 |
| | 20 | 7.2±0.15 | 1246±1.52 | 1122±2.5 | 205±2.64 | 271±2.64 | 6.2±0.1 | 13±1 | 59±3 |
| | 30 | 7.1±0.15 | 1104±3.05 | 1080±3 | 175±22.64 | 238±2.08 | 6.5±0.15 | 11±1 | 56±2.08 |
| 10 mg/l EDTA | 10 | 7.5±0.1 | 1273±3.51 | 1140±2 | 263±3.51 | 279±2.51 | 5.4±0.32 | 13±1.53 | 97±2.64 |
| | 20 | 7.3±0.25 | 1238±2.08 | 1104±2.08 | 185±3.21 | 250±1.52 | 6±0.32 | 10±2.08 | 85±2.52 |
| | 30 | 7.2±0.2 | 1189±3.05 | 1061±2.64 | 142±2.64 | 214±1.53 | 6.6±0.26 | 9±2.08 | 65±2.65 |
| 100 mg/l EDTA | 10 | 7.3±0.25 | 1262±2.52 | 1096±2.64 | 179±2.52 | 262±2.08 | 6.9±0.20 | 10±2.64 | 72±3.05 |
| | 20 | 7.3±0.15 | 1175±1.53 | 995±3.05 | 151±2.51 | 165±3.05 | 7.3±0.15 | 9±1.51 | 77±2.08 |
| | 30 | 7±0..1 | 1095±3.21 | 832±3.21 | 130±1 | 120±2.51 | 7.6±0.3 | 8±1.51 | 61±2.08 |

Figure-2 Graphical representation of pH from treated water sample

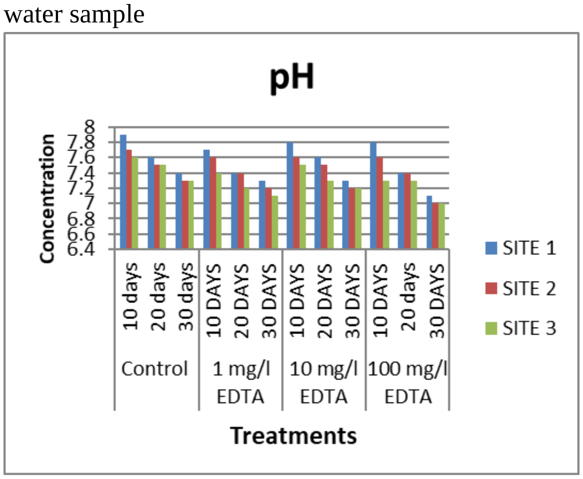



Figure-3 Graphical representation of Electrical conductivity from treated water sample

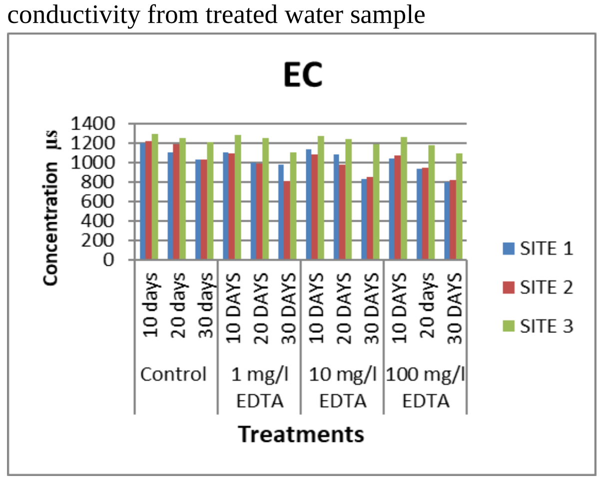


Figure-4 Graphical representation of TDS from treated water sample

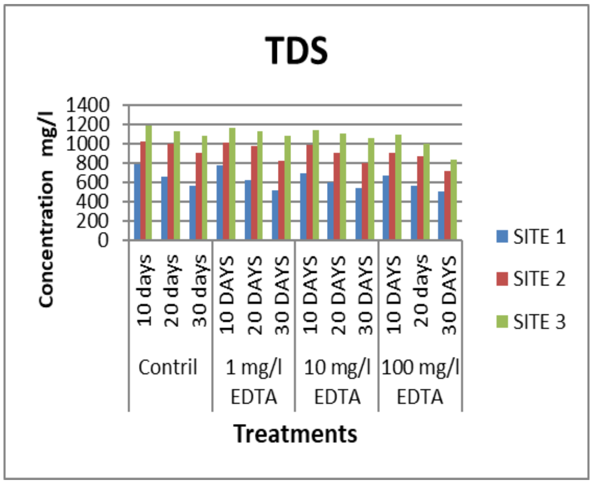



Figure-5 Graphical representation of Total alkalinity from treated water sample

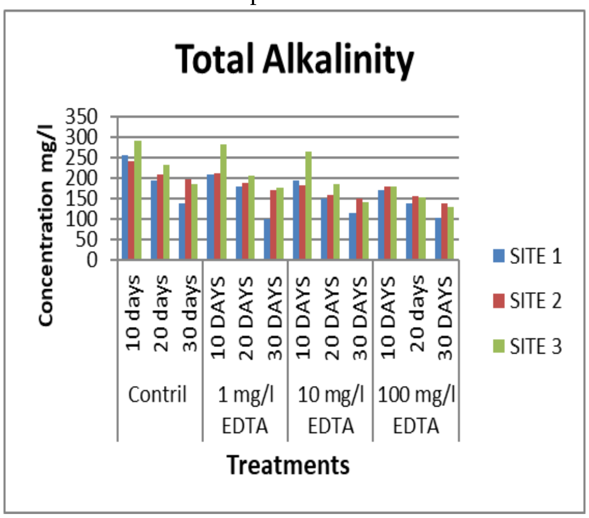



Figure-6 Graphical representation of Total hardness from treated water sample

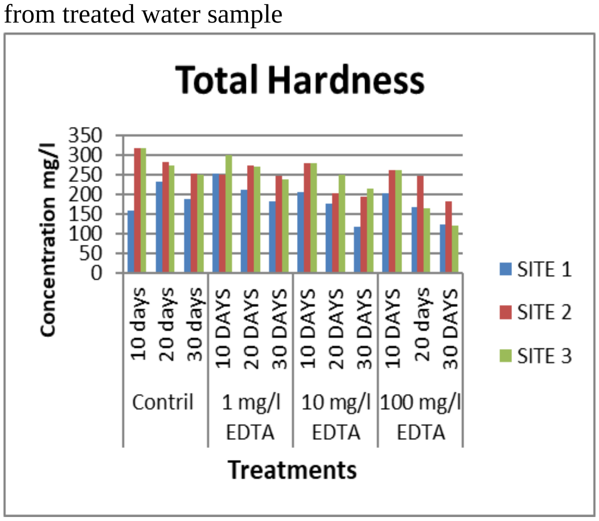



Figure-8 Graphical representation of Dissolved oxygen from treated water sample

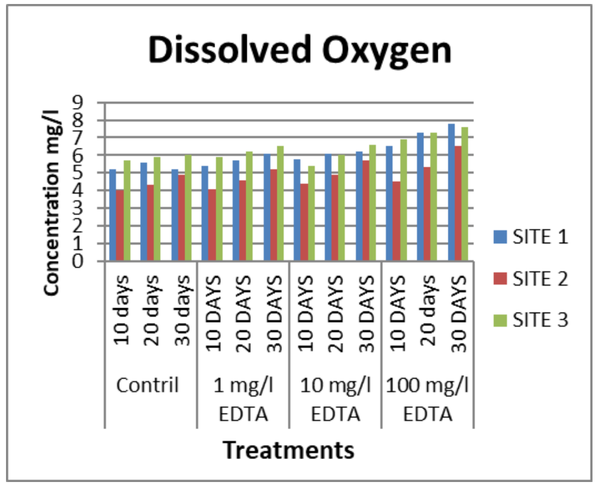



Figure-9 Graphical representation of BOD from treated water sample

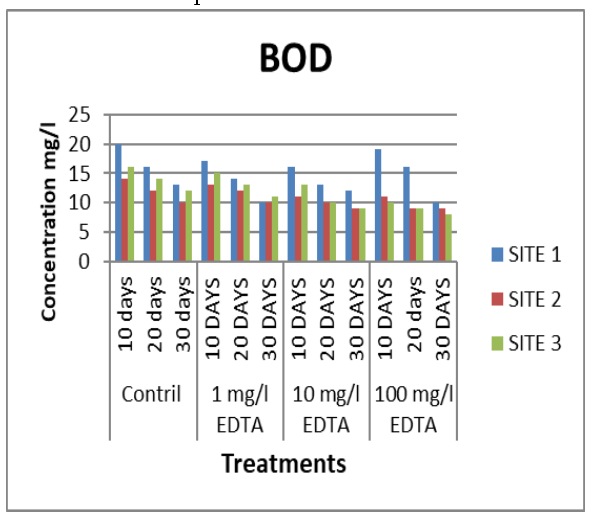
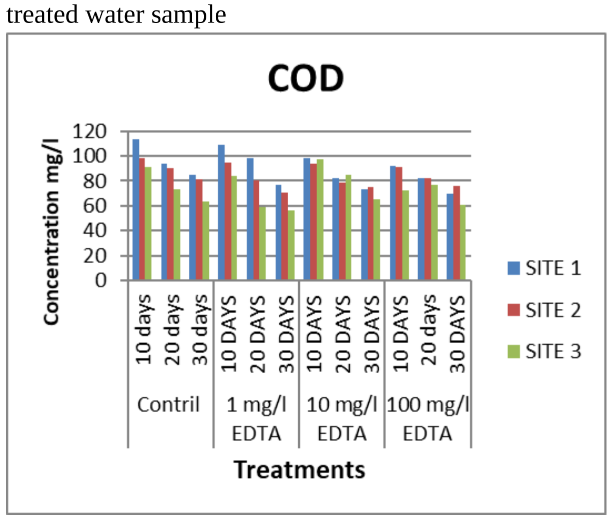



Figure-10 Graphical representation of COD from treated water sample



## COCLUSION

Experiment on the reduction of physicochemical parameters by green technology proved that the plant *Eichhornia crassipes* used in the stuty was able to remove the physicochemical parameters include pH, electrical conductivity, TDS, total alkalinity, total hardness, dissolved oxygen, BOD and COD. In summary the addition of EDTA to contaminated water of Yamuna River can enhance the reduction of physicochemical parameters.

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