Effect of Phytoremediation on Koradi Lake Water

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Abstract— Surface water is more prone to pollution than ground water. The impacts of surface water pollution are also instant, severe and visual. Unlike rivers which possesses self-cleaning capacity, it is also difficult to clean the stagnant water in lakes, ponds etc. Koradi Lake near Nagpur is one such example as the lake is facing the issue of water pollution. The sources of this lake pollution varies from sewage water discharge from nearby villages, cooling water disposal from adjacent Thermal Power Station, runoffs, idol and Nirmalya immersions and many more. The focus of the project is to identify the naturally occurring plant species which can be helpful in removing the pollutants and reducing the impacts of polluted water. Four different species were considered and used for phytoremediation, two aquatics species Azolla Pinnata and Water Hycinth and two media based species Canna Indica and Colocasia Esculenta. The lake water was introduced for a period of 20 days and observed. The Phytoremediation capacity of aquatic species was found to be much better than the Phytoremediation capacity of media based species. Moreover, the lake water showed adverse effects on the growth of media based species, which opens the scope for further research regarding the quality and contents of water.

Keywords: Phytoremediation, water treatment, waste water treatment, remediation by plants

I. INTRODUCTION

Water is the prime requirement of human beings, plants and animals for their survival. It is the essential factor of our life. Nature has given abundant amount of resources on this planet for the survival of all living being. However, it is the human intervention that has degraded the resources. Many factors are responsible for the change in the natural environment. It is due to over population that man has to over utilize the water. Industrialization further created lot of trouble and polluted many of the natural water bodies. The lack of knowledge and ignorance has severely impacted our surroundings. This has led to the scarcity of pure water on the planet. Even the groundwater levels are decreasing at many places. The degrading quality of water has put an alarm worldwide and most of the countries have come forward and started taking initiatives for water treatment and purification.

In India, a similar situation can be seen. At many places the sewage water, industrial water and other waste waters are directly discharged into the water bodies without providing any treatment. This has degraded the quality of water and most of the surface water bodies are polluted or contaminated. The Koradi Lake near Nagpur, Maharashtra is one such example of highly polluted lakes. This is an artificial lake made as an intake pond for Kotadi Thermal Power Station. The sewage water from nearby colonies is directly discharged into the lake without any treatment. The runoff water from nearby fields is also joining the lake water which has Eutrified the lake due to the presence of fertilizers and pesticides. The cooling water from the nearby Thermal Power station is also discharged in the lake directly. The lake was also been used for idol immersion for many years now and the Nirmalya and idols of different materials are commonly seen floating and on the banks of lake water. All these have degraded to quality of lake water to a greater extent and even the depth of the lake is reduced due to siltation.

Immediate attention is required to stop further degradation of lake as well as the cleaning and purification of the lake. All the above mentioned practices need to be closed. The sewage water should be treated before releasing to the lake. The idol immersion should be stopped and a separate tank should be prepared for the same. The cleaning of lake should be done in order to remove the overly grown local species and the silt present in the lake. Phytoremediation can be considered as an option to clean the lake naturally. Phytoremediation has emerged as a cheapest and eco friendly option for water treatment in recent years. It has many advantages over the conventional treatment procedures and has proven an easy and effective remediation technique. Many species are already tested for phytoremediation efficiency according to availability and capacity to uptake the pollutants.

This experiment is conducted in order to check the phytoremediation capacity of four different species, Canna Indica, Colocasia Esculenta, Water Hycinth and Azolla Pinnata. All these species are locally available and sustainable in local environment. The adaptability of species to Koradi Lake water and uptake capacity was checked in the course of experiment.

II. METHODOLOGY

A. Materials:

The experiment set up consisted of 1 drum of capacity 50 liters for raw water from Koradi Lake. The drum is attached with 4 pipes and taps to distribute the raw water in the collected species. Four tubs were taken of equal size with taps arranged in the bottom of the tubs. Two tubs were filled with sand, Gravel and soil and a media is created. Two fully grown terrestrial species, i.e., Canna Indica and Colocasia Esculenta were collected locally and introduced to the media based tubs. Other two aquatic species, i.e., Water Hycinth and Azolla Pinnata were collected from Botanical departments of Institute of science, Nagpur and University Botanical Department, Nagpur and introduced in remaining two tubs. Raw water was collected from Koradi Lake.
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B. Experiment:

Raw water collected from Koradi Lake was tested for the Physico-chemical Parameters. The parameters like pH, Turbidity, Electrical Conductivity, Hardness, Total Dissolved Solids and DO were measured. The water is then introduced to all the four species and observed for the remediation period of 20 days. After 20 days, the water samples from all four species were collected through the taps provided at bottom of the tubs. The physico chemical parameters of these samples were checked in the laboratory. Same procedure was followed for the month of October, November, December, January and February.

To observe the changes in parameters of raw water without introduction of any species, a controlled system was kept for 20 days and observed. Since the removal of Total dissolved solids were also seen, the nutrients of all the four samples and the raw water sample were checked from the laboratory.

III. RESULTS AND DISCUSSIONS

The analysis of water samples after 20 days remediation period shows that all the four species reduce the pollutants to some extent. The results are shown in figures 3 to figure 4.

A. pH:

The pH of raw lake water was found to be varying between 8.22 to 8.79. The raw water was alkaline in nature. After remediation with all four species for 20 days period, the pH was found to be near to neutral. Both the terrestrial species Canna Indica and Colocasia Esculenta brought down the pH value to 8.10 on an average. This means an average reduction of 4.7% in pH values were noticed in terrestrial species. While the aquatic species Water Hycinth and Azolla Pinnata was more effective to bring down the pH to 7.83 and 7.73 respectively on an average. On an average 8.0% and 9.2% respectively change was found in pH values of samples treated by aquatic species. Figure shows the monthly recordings of pH values for all five samples. The change in pH for controlled unit was found to be 4.3% only.

B. Turbidity:

The Lake water was highly turbid. The average turbidity was found to be 88.44 NTU for Raw water sample. The controlled unit showed that 73% particles gets settled down. The samples from the species showed that around 82% - 84% turbidity was removed by Canna Indica and Colocasia Esculenta. The average reading varied between 13.1 NTU to 15.4 NTU. The water obtained from aquatic species was clearer as the removal efficiency varied between 92% - 96%. The average reading was between 3.5 NTU to 6.5 NTU.

C. Electrical Conductivity:

The Electrical conductivity for raw water sample was 0.56 mho. The same was reduced to 0.39 mho in controlled unit, which is around 32% drop. The same drop of around 33% to 34% was seen in terrestrial plants. The aquatic plants were also found to be reducing the electrical conductivity by 38% - 46%. The average readings were about 0.30 mho. Below figure shows the drop in electrical conductivity for each month.
D. Total Dissolved Solids:

The total solids in raw water sample were more than 1200 mg/l. The controlled unit showed that around 71% total solids were settled on their own. The samples from the species shows that around 78% total solids were removed by Canna Indica and around 76% solids were removed by Colocasia Esculenta. The aquatic species removed almost 80% of the total solids. The average readings came down to around 240 mg/l for aquatic species samples. Figure shows the readings for all months.

E. Hardness:

Raw water sample from the lake was found to be very hard. The average readings showed that more than 750 mg/l hardness was found in raw sample. The Hardness of water remained unchanged in the controlled unit as only 0.39% change was noticed. The terrestrial species also were not too effective in reducing the hardness. Only 8% to 17% harness removal was noticed in Canna Indica and Colocasia Esculenta. Among the aquatic plants, Water hyacinth was found to be reducing the hardness around 11% only. However, it is Azolla Pinnata which was more effective in reducing the hardness. Around 23% hardness was removed by Azolla Pinnata. The mechanism of hardness removal of Azolla Pinnata has already been discussed by many authors. Azolla has proved to be effective in removal of hardness from water and waste water as the plant cell walls are capable of exchanging the ions with heavy metals (Sood et al. 2004; Taghi ganji et al. 2005). Following figure gives the graph of hardness removal for all the months.

F. Dissolved Oxygen:

Dissolved oxygen is another important parameter of water. The dissolved Oxygen (DO) of lake water is important for aquatic life of the lake. The raw water sample shows that the DO is more than the desirable limits. The analysis has shown that the DO of raw water was up to 10.33 mg/l. The plants were effective in bringing down the DO limits of treated water samples. The Canna Indica and Colocasia Esculenta reduced almost 32% of DO and brought the DO level to 6.6 mg/l on an average. The aquatic species were more effective here also as Water hyacinth and Azolla Pinnata reduced the DO level by almost 41% to 47% and brought down the readings to 5.8 mg/l and 5.24 mg/l respectively on an average.

G. Nutrients:

The nutrients were analyzed in order to check whether the plants are absorbing the nutrients, which is a factor for reduction in turbidity and Total dissolved solid levels of the water. The nutrients (NPK) were analyzed from the laboratory for one sample of raw water and one sample of treated water from each species.

The raw water sample showed the Nitrate content of 0.92 mg/l. All the four species had removed the Nitrate contents and brought down the readings below 0.2 mg/l. The nitrate from the water was absorbed by all the four species in effective manner.
The Phosphate content in the raw water sample was found to be around 5.3 mg/l. The plants absorbed the phosphorus from the water and brought down the levels to 2.7 mg/l, 2.9 mg/l, 2.2 mg/l, and 1.7 mg/l. All the four species absorbed the phosphorus from the water in an effective manner.

The Potassium in the raw water sample was found to be around 2.14 mg/l. After remediation period, the potassium content was found to be reduced by all the four species. The levels were reduced to 1.29 mg/l, 1.6 mg/l, 1.78 mg/l, and 1.04 mg/l respective in all the four samples.

H. Other Observations:

There were also some observations which were vital to be mentioned. The 6 months exposure of Koradi Lake water to Canna Indica had shown adverse effects on the plants. The otherwise flowery plant didn’t grow a single flower during the experiment period. After six months, when the lake water was removed and the normal tap water was introduced to the plant, the flowers started blossoming again.

Same effect was seen on Colocasia Esculenta. The leaf size of initial plant was very big. However, during the course of experiment, the leaf size went on reducing. After exposure of 6 months to Koradi Lake water, the leaf size of the plant remains only 30% of the original.

Water Hycinth also has shown some adverse effects in terms of reduction in plant size. The initial plant was more than 28 cm high. However, after 6 months of exposure to lake water, the height of the plant reduced to just 10 cm.

IV. CONCLUSION

The raw water sample analysis of Koradi Lake showed that the lake is highly polluted. Immediate attention of the authorities is required to avoid further degradation and for cleaning of the lake. The idol immersion should be banned and separate ponds should be made for the same. Phytoremediation can be provided as a treatment measure for the sewage entering directly the lake. Also phytoremediation is good option as it will help to remove the pollutants from otherwise stagnant water. From above experiment, it can be suggested that Water Hycinth and Azolla Pinnata are good options for phytoremediation of Koradi Lake. These aquatic weeds are very effective in accumulation of pollutants, nutrients and even heavy metals if any. Azolla Pinnata is one of the fastest growing weeds. It is rich in proteins and is a very nutritious feed for Livestock. Hence the high biomass production can also be utilized as livestock feed. The combination of Water Hycinth along with Azolla can give higher rate of water purification.

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