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Research Article

PHYTOREMEDIATION OF TREATED INDUSTRIAL EFFLUENT COLLECTED FROM AHMEDABAD MEGA PIPE LINE

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ABSTRACT

Present paper deals with phytoremediation ability of *Pistia stratiotes* L. Accumulation ability of *Pistia stratiotes* L. has been used to remediate treated industrial effluent collected from Ahmedabad mega pipe line. Industrial effluents released by Ahmedabad GIDC cluster are treated at central effluent treatment plant (CEPTs). Treated effluents are released into Sabarmati River through mega pipe line. Study reveals decrease in turbidity, chloride content, calcium hardness, acidity, dissolved oxygen, biological oxygen demand and chemical oxygen demand due to remediation property of *Pistia*. Study also adds growth rate of *Pistia* in effluent of Ahmedabad mega pipe line.

INTRODUCTION

Plants are well significant for water refinement and water control. Plants are used to purification of water from ancient time. Early man believed that purity of water regulated by way of its appreciation; if water had a pleasing taste then it was perfect. As a consequence, the method of making pure water in ancient time was to add herbs and flower of different plants to the water (AWWA, 1971). Trees like Amla, which is high in vitamin C and grass like Khus (*Vetiveria zizanoides*), were often used in well filtration of water. Water lily roots and the seeds of the Nirmali (*Strychnos potatorum*) are also of great importance to purify water in ancient. Water lilies (*Nymphaea*) were applied to restore the purity of rivers and water sources (Rajiv Gupta, 2009).

Phytoremediation is the use of plants to remedy contaminated soils, sediments, and groundwater. Some plants can hyperaccumulate toxic heavy metals in their tissues (Ndimele, 2003). Others can convert the pollutants to less toxic compounds and volatilize them (Terry and Zayed, 1994; Brooks, 1998). Some aquatic plant roots can filter contaminants/ pollutants from water (Brooks and Robinson, 1998).

Development of industries is increasing day by day. With these development, safe disposal of industrial waste become most challenging task. Therefore, environment degradation has now become a global problem. Due to lack of effluent treatment facilities and proper disposal system of wastewater, waterbodies polluted day by day. Disposal of industrial effluents into fresh water bodies deteriorates water quality, which is necessary to sustain aquatic life (Rao, *et al.*, 2001).

For treating contaminated wastewater, the phytoremediation plants are grown in a bed of inert granular substrate, such as sand or pea gravel, using hydroponic or aeroponic techniques (Keeratiurai, 2013). The wastewater, supplemented with nutrients if necessary, trickles through this layer, which is ramified with plant roots that serve as a biological filter and a contaminant uptake system. An added advantage of phytoremediation of wastewater is the considerable volume reduction attained through evapotranspiration (Hinchman and Negri, 1994).

Now a days it has been found that several aquatic plants have the ability to remediate water bodies

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polluted by industrial effluents. Thus, aquatic vascular plants are getting more attention for their possible role in screening, phytotoxicity studies of chemicals and as a useful bioindicators (USEPA, 1996). Some plants show positive effect and some show negative effect on industrial effluents.

Using macrophytes for phytoremediation is a non-invasive strategy for sustainable treating polluted water bodies, and after sequestering pollutants, macrophytes can be harvested and taken away from the water and their biomass used as a soil conditioner; alternatively, the pollutant can be reclaimed and purified from the plant tissue (Paz-Alberto and sigua, 2013).

The present study shows phytoremediation of industrial effluents released by industries in Ahmedabad. The overarching purpose of this task is to optimize a series of schemes that can improve water quality by exploiting the ability of aquatic plants to assimilate waterborne pollutants.

MATERIALS AND METHODS

Study area

Ahmedabad is the largest city and former capital of Gujarat. The city is located on the banks of the Sabarmati River, 30 km (19 mi) from the state capital Gandhinagar. Ahmedabad lies at 23.03°N 72.58°E in western India at 53 meters (174 ft) above sea level on the banks of the Sabarmati River, in north-central Gujarat. It covers an area of 466 km^2 (year 2006). With a population of more than 6.3 million and an extended population of 7.2 million, it is the sixth largest city and the seventh largest metropolitan area of India. Ahmedabad is divided by the Sabarmati into two physically distinct eastern and western regions (Shah, *et al.*, 2014).

Ahmedabad Mega pipeline is situated at 22°58'53.42"N 72°32'33.71"E near Gyaspur Village. Mega pipeline is 27 kms long and receives treated effluent of industrial cluster Vatva, Naroda, Odhav and Narol. Mega Pipeline from Naroda to Pirana has carrying capacity of 90 MLD. It is an outlet of Central Effluent Treatment Plant (CETP). Earlier there was a direct discharge of effluent by industrial units into Khari cut canal. But there is no direct discharge of effluent into Khari cut canal after High Court directives and subsequent vigilante actions by GPCB. Individual industrial units have provided Primary effluent treatment plants. Treated wastewater is discharged into CETP. The treated effluent from CETPs is discharged into Mega pipeline. (GPCB Gandhinagar, 2010) (Fig. 1 and 2).

Sampling

Collection of water samples: Water sample has been collected from outlet of pipe. Initially the prewashed bottles were rinsed with sample water. The closed bottle was dipped at the depth of 0.5 to 0.7 m. and then a bottle was opened inside and was folded again to take it out at the open. The samples were gathered up from five different points and were amalgamated together to make an integrated sample.

Collection of *Pistia*: *Pistia* were collected from

Fig. 1 Mega pipeline, Gyaspur village, Ahmedabad.

unpolluted areas and also from natural habitat. They were collected from Serenity library, Ahmedabad.

Experimental setup: Two container for water sample were taken. Equal amount of water sample were taken in to both container and equal amount of *Pistia* were introduced into container. Physiochemical analysis of sample water were done after 6 days and after 12 days.

For growth rate study of *Pistia* into treated effluent four beaker with water sample were taken. *Pistia* at four leaf stage were introduced into beakers. Another replicate of the first set was also taken.

Physiochemical analysis of water: pH, Turbidity, Total dissolved solids, Chloride, Calcium hardness, Alkalinity, Acidity, Dissolved oxygen, Biological oxygen demand, Chemical oxygen demand has been assessed for physiochemical analysis of water.

"Standard Methods for the Examination of Water and Wastewater (Standard Methods)", 19th edition, APHA, AWWA, WEF, 1995 were used for analysis of water samples. Results are compared with standards given by the Central Polluton Control Board.

Growth rate assessment: For the study of plant growth rate following parameters were examined. Yield components such as number of leaves, root length, leaf length were taken. Root weight and leaf weight, fresh weight and dry weight of plant at each stage were taken.

Estimation of chlorophyll content: Total Chlorophyll content was estimated according to Arnon's method (1949).

RESULTS AND DISCUSSION

Effect on physio-chemical parameters

pH: pH of water on day 1 was acidic in nature. Acidic nature of effluent was may be due to release of acidic chemicals of textile units. pH of effluent was increased as days passed. It became alkaline after 12 days. It is also well known that water pH rises with plant photosynthesis. Permissible limit of pH is 5.5-9.0 (The Environment Protection Rules, 1986). Here pH of effluent was within permissible limit. Thus effluent attains alkaline nature from acidic as days passed. (Qin Lu, *et al.*, 2010) reported opposite results for pH with *Pistia stratiotes* L (Fig. 3).

Turbidity: Effluent sample was semitransparent with 21.3 NTU turbidity. High turbidity of effluent was due to presence of large amount of suspended solids. Turbidity of effluent decreased after 12 days was might be due to decreases in solids by plant uptake. Here turbidity was within permissible limit which was 300 NTU (The Environment Protection Rules, 1986). (Qin Lu, *et al.*, 2010) also reported same results in *Pistia* where turbidity was decreased by 60%. (Akinbileab and Yusoffa, 2012) also reported decrease in turbidity by 93.60% with *Pistia stratiotes* L (Fig. 4).

Total dissolved solids: TDS of collected effluent was above permissible limit which was 2100. TDS were increased might be due to addition of carbonates and

Fig. 2 Effluent discharge at mega pipeline.

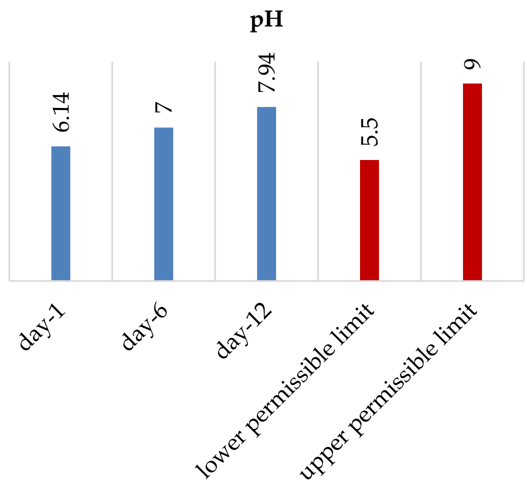

Fig. 3 pH.

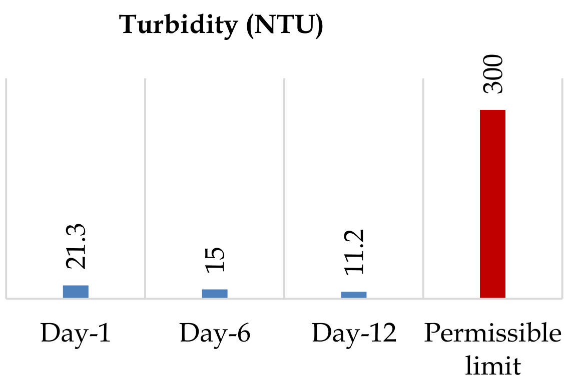

Fig. 4 Turbidity.

bicarbonates by decomposition of *Pistia* and also due to increase in residue by evaporation. After 12 days it attains very higher amount then permissible limit (Fig. 5).

Chloride: Chloride content of collected effluent was 487.94 on day 1. It was due to industrial waste. Chloride content in effluent was decreased after 12 days due to uptake by *Pistia*. Chloride was within permissible limit which is 1000 mg/l (The Environment Protection Rules, 1986) (Fig. 6).

Calcium hardness: Calcium hardness of collected effluent was above permissible limit which is 100 mg/l. Calcium hardness of effluent decreased after days which showed absorption of calcium by Pistia for its metabolic activities. After 12 days it went within permissible limit (Fig. 7).

Alkalinity: Alkalinity of effluent on day 1 was 815.33 which was maybe caused by dissolved bases such as sodium or potassium hydroxide, hydrogen ions are always present in water, even if the concentration is extremely small. Alkalinity increased after days which was due to increase in pH value of effluent (Fig. 8).

Acidity: Acidity is measures of hydrogen ions in water. Acidity is directly related to pH. It is inversely proportional to pH value, higher the pH, lowers the acidity of water. Acidity of collected effluent was decreased after 12 days which was due to increase in pH value (Fig. 9).

Dissolved Oxygen: DO is related to temperature, as temperature rises DO is decreases or vice-versa. High COD levels decrease the amount of dissolved oxygen

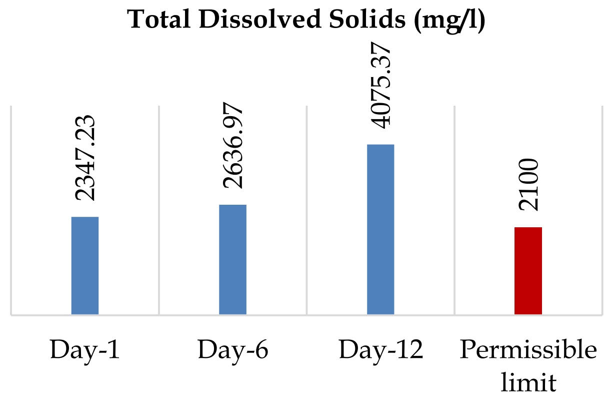

Fig. 5 Total dissolved solids.

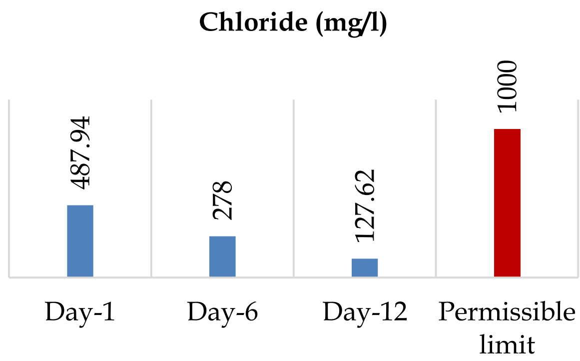

Fig. 6 Chloride.

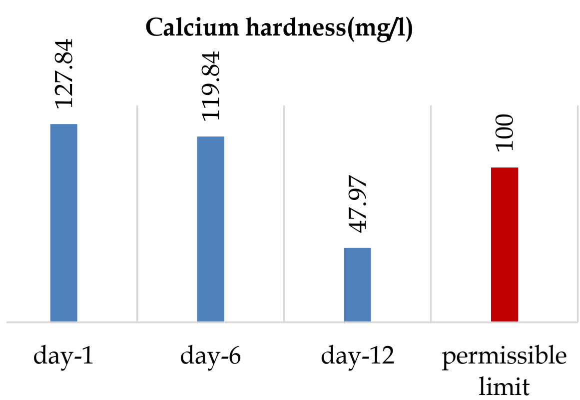

Fig. 7 Calcium hardness.

available for aquatic organisms (U.S. EPA, 2010). Dissolved oxygen level was decreased which was might be due to rise in temperature and, increased amount of COD (Fig. 10).

Biological Oxygen Demand: BOD is one of the most common measures of pollutant organic material in water. BOD indicates the amount of putrescible organic matter present in water. Therefore, a low BOD is an indicator of good quality water, while a high BOD indicates polluted water (Encyclopedia of public health). BOD of collected effluent was within permissible limit which was 350. After 12 days BOD of effluent decreased which indicates decrease in organic matter, also indicates good water quality (Fig. 11).

Chemical Oxygen Demand: COD of collected effluent found very high which was above permissible limit. Permissible limit of COD is 100. COD of collected effluent observed decreased which was above permissible limit. (Akinbileab and Yusoffa, 2012) also reported decrease in COD with *Pistia* (Fig. 12).

Effect on Biomass: There was considerable reduction in dry weight of Pistia. There was decrease in dry weight due to stress condition after 12 days. Pista showed healthy growth in control.

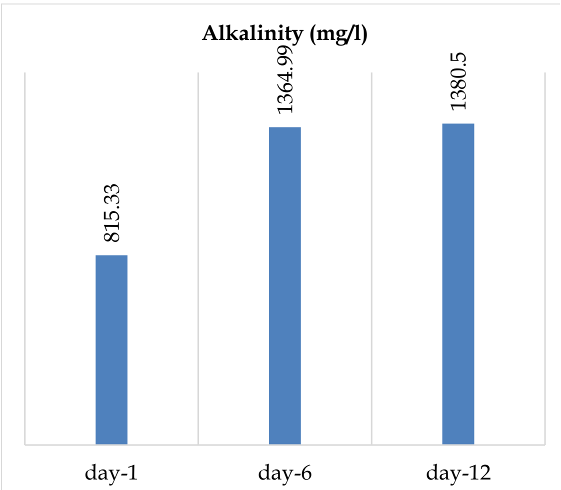

Fig. 8 Alkalinity.

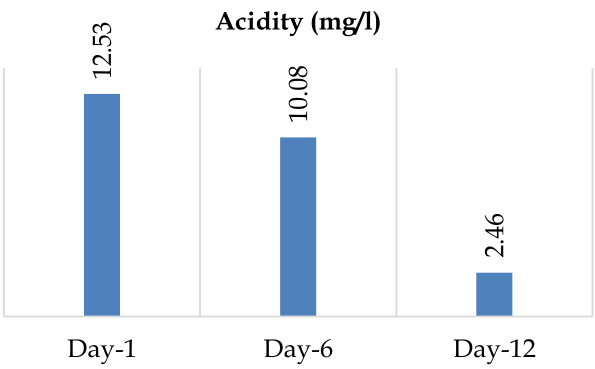

Fig. 9 Acidity.

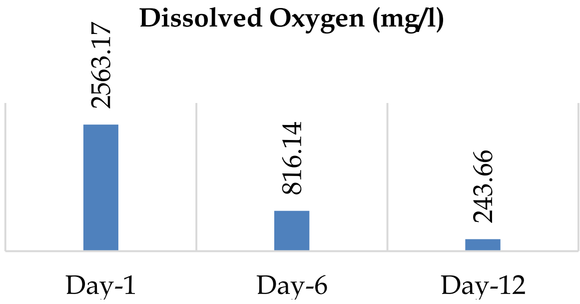

Fig. 10 Dissolved oxygen.

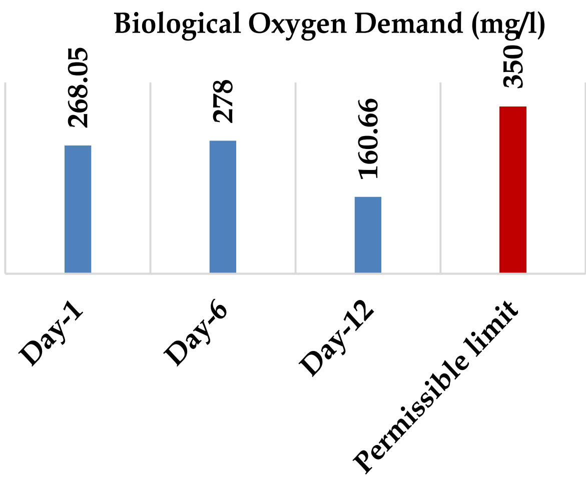

Fig. 11 BOD.

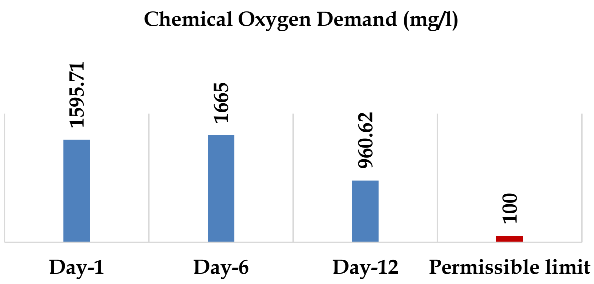

Fig. 12 Chemical oxygen demand.

Reduction in biomass was due to decreased level of nutrients in effluents and stress condition. The decrease in biomass took place due to disturbed carbohydrate and nitrogen metabolisms and reduction in protein synthesis or low photosynthetic reactions under metal stress conditions (Barcelo, *et al.*, 1993) (Fig. 13).

Effect on chlorophyll content: Total chlorophyll of *Pistia* leaves increased as days passed which was might be due to uptake of magnesium by *Pistia* from effluent and also due to metabolic activity of *Pistia* (Fig. 14).

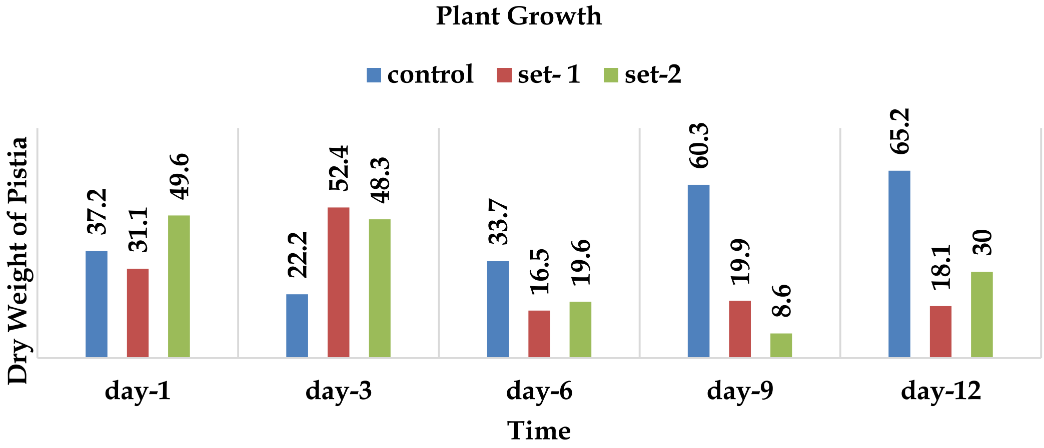

Fig. 13 Plant growth rate.

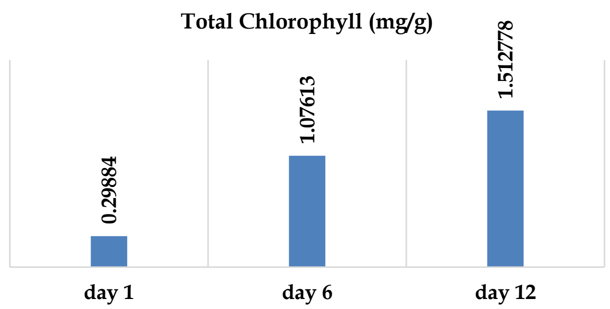

Fig. 14 Total chlorophyll.

CONCLUSIONS

1. Water analysis of the study revealed that there is decrease in turbidity, chloride content, calcium hardness, acidity, dissolved oxygen, biological oxygen demand and chemical oxygen demand due to accumulation properties of *Pistia.*

2. There has been also observed some great changes that total dissolved solids, calcium hardness, chemical oxygen demand were out of permissible limits, after 12 days Calcium hardness reduced under permissible limit which is due to accumulation ability of *Pistia.*

3. It has been observed that due to diverse effect of industrial effluent there is gradual decrease in plant growth. Total chlorophyll content was increased as days passed, the data can also be correlated with uptake of magnesium from water by *Pistia.*

4. An experiment was done for accessing effect of *Pistia* on effluent. The results shows that phytoremediation purpose is solving up to some extent. We still don't know resistance of *Pistia* in extreme polluted water.

5. There is need to take up more studies on site specificity of Phytoremediation, Influence of micro population and use of genetic modified plants.

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