Efficacy of *Canna indica* L.: A Potential Tool for Phytoremediation

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Abstract:

The quality of the lithosphere, biosphere, atmosphere, hydrosphere, and biosphere are all impacted by environmental contamination. Over the past 20 years, a lot of work has been done to mitigate pollution sources and clean up contaminated water and land. In both academic and practical circles, phytoremediation is becoming more and more popular since it is less expensive and has fewer negative consequences than chemical and physical techniques. This paper attempted to assess the phytoremediation capacity of the plant *Canna indica* L. Culturing of this plant was done in kitchen waste water for 10 days. Waste water quality was analyzed before and after treatment by analyzing physical chemical properties. In order to know improvement in quality of wastewater different physical chemical parameters was analyzed. *Canna indica* showed an excellent potential of phytoremediation against the kitchen waste water.

Keywords: *Phytoremediation, Canna indica, pollution, waste water*

Introduction:

Phytoremediation is a cost-effective green technology based on the use of plants to remove, metabolize, assimilate, or absorb hazardous materials in soil (Wu *et .al,* 2015). The knowledge that aquatic or semi aquatic plants such as water hyacinth (*Eicchornia crassipes*), pennyworth (*Hydrocotyle umbellate*), duckweed (*Lemna mino*r) and Water velvet (*Azolla pinnata*) can take up Pb, Cu, Fe, and Hg (lead, copper, cadmium, iron, mercury) from contaminated solutions which existed for a long time. This ability is currently utilized in many wetlands, which may be effective in removing some heavy metals as well as organics from water. One phytoremediation method called rhizofiltration uses plant roots to absorb, concentrate, and precipitate metals out of water (Zhu *et .al,* 1999). Because they have larger surface areas for metal sorption and longer, tougher, and typically fibrous roots, terrestrial plants are thought to be better suited for rhizofiltration (Dushenkov *et .al,* 1995). *Canna indica* L. (Cannaceae) is an excellent option for removing heavy metals from contaminated water. Because it possesses a number of crucial characteristics of plants appropriate for phytoremediation.

Phytoremediation is proposed as a cost-effective plant based approach of environmental remediation that takes advantage of the ability of plants to concentrate elements and compounds from the environment and to detoxify various compounds. The concentrating effect results from the ability of certain plants called hyper accumulators to bioaccumulate chemicals.

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Several field trials confirmed the feasibility of using plants for environmental cleanup. This study threw light on potential of *C. indica* for phytoremediation. The highlight made through this work with continued screening of the species *Canna indica* with a high potential for contaminant uptake and will contribute to the development of new and more effective phytoremediation approach.

Material and Methods:

Phytoremediation of domestic kitchen wastewater was done by using plant *Canna indica* L.

Experimental set up: The plants were collected from nearby areas, then they are washed thoroughly with tap water to the prior to the experiment. Collected plants are grown in 250 ml beakers filled with wastewater. The above setup was kept for 10 days and sample analysis was done. The parameters taken for assessment were pH, Electrical conductivity, total dissolved solids (TDS), COD, alkalinity and acidity. Wastewater must be tested with different physical-chemical parameters. Some physical parameters should be performed for testing of its physical appearance such as temperature, colour, odour, pH, TDS etc. while chemical tests should be performed for its COD, alkalinity, acidity etc. The results of the analysis of wastewater samples are expressed in terms of physical and chemical units of measurement.

Methods:

pH (APHA 1992):

pH was determined at the site by the potable water analyzer (systronics) and was confirmed by electrometric pH meter. The probe was immersed directly in the water collected in a wide mouthed sampling bottle at the sampling site immediately after collection for a period of time sufficient to permit constant reading.

Electrical conductivity (APHA 1992):

Conductivity is the capacity of water to conduct electric current and varies both with number and types of ions in the solution. The values of conductivity and TDS are interrelated.

Conductivity meter, was used to measure conductivity and expressed as m mhos or µ mhos/cm or as µS/cm.

Total dissolved solids (TDS) (APHA, 1992):

An electronic probe, which measures TDS was used. The values are expressed as mg/L of water. The probe was immersed directly in the water collected in a wide mouthed sampling bottle at the sampling site immediately after collection for a period of time sufficient to permit constant reading.

Alkalinity (APHA,1992):

Alkalinity was measured by *Sulphuric* acid titration method. The alkalinity of water is a measure of its capacity to neutralize acids. The alkalinity of water sample is recorded as follows**:**

P (phenolphthalein alkalinity), mg/L= A * 1000 / ml of sample

T (total alkalinity), mg/L= B * 1000 / ml of sample

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In case $H_2 SO_4$ is not 0.02 N, then the following formula is applied

Alkalinity, mg/L = A / B * N * 50000 / ml of sample

Where,

A = ml of required to change from pink to colourless with phenolphthalein indicator

B = ml of $H_2 SO_4$ required to change from yellow to pinkish orange with methyl orange indicator

N = Normality of $H_2 SO_4$ used

Chemical Oxygen Demand (COD) Open Reflux method, using potassium dichromate (APHA, 1992):

COD is the oxygen required by the organic substances in water to oxidize them by a strong chemical oxidant. This shows the oxygen equivalent of the organic substances in water that can be oxidized by a strong chemical oxidant such as potassium dichromate in acidic solution. COD is the measure of oxygen consumed during the oxidation of the oxidisable organic matter by a strong oxidising agent. Potassium dichromate ($K_2 Cr_2 O_7$) in the presence of sulphuric acid is generally used as an oxidisng agent in the determination of COD. The sample is treated with potassium dichromate and sulphuric acid and titrated against ferrous ammonium sulphate (FAS) using ferroin as an indicator. The amount of ($K_2 Cr_2 O_7$) used is proportional to the oxidisable organic matter present in the sample.

COD value is calculated as,

COD (mg/L)=(Volume of titrant used in blank – volume of titrant used in sample) * N of FAS * 8 * 1000 / volume of sample taken.

Results And Discussions:

A experiment was designed to check the phytoremediation properties of *Canna indica* (Figure 1) on kitchen waste water.

Fig. 1: Experimental set-up for phytoremediation with *Canna indica* L. pl

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Phytoremediation of wastewater was done using *Canna indica* L. The results of the study are given in table 1. Different parameters showed gradual change after treatment with the plant. In this study the plants the plant *Canna indic*a L. are collected from Kolhapur region. Both physical and chemical parameters were observed. Odour in domestic wastewater was caused due to decomposition of organic matter or from the substances added to the wastewater. There has been change in odour of waste water after the treatment with the plant. Colour of the wastewater which is typically of grey in color has been changed to normal. In the chemical and biological activities of water bodies, temperature place in wide. It always got influenced by external environmental conditions. So, there is radiation in temperature values in the culture of the plant.

Conductivity of water depends upon concentration of the salt ions and water temperature. Electrical conductivity of water helps to indicate waters purity. The pure water always has lower conductivity. As the concentration of dissolved ions increases, the ability of water to conduct electrical current also increases. It has been observed that, the conductivity got reduced in wastewater treated with *Canna indica* L. Total dissolved solids (TDS) value is an important parameter in drinking water and other quality standards. In the present study, TDS value had decreased from the first day in treated water. pH in water gives a straight picture of its acidic or alkaline nature and considered to be a significant parameter in water quality assessment. In the present study, slight variations were observed in pH values. pH values after treatment was decreased slightly. pH values got increased in first few days then it got reduced with slight variations. Acidity is the quantitative capacity of aqueous media to react with OH^- ions or to accept electrons.

In present work, acidic value gradually decreased after treatment of ten days. Total alkalinity is a measure of the buffer capacity of the water. Alkalinity is a measure of buffering capacity of water and is important for aquatic life in a freshwater system because it equilibrates the pH changes that occur naturally as a result of photosynthetic activity of phytoplankton (Kaushik and Saksena, 1989). In general, alkalinity should not be less than 30 mg/L and values higher than 400 to 500 mg/L are considered too high. Alkalinity after the treatment was reduced due to the absorption of dissolved solids.

COD is a measurement of oxygen consumed during the oxidation of oxidizable organic matches by using a strong oxidating agent. The higher value of chemical oxygen demand indicates that higher organic pollution in water sample. After treatment with plant, COD values have increased from the day of treatment.

DAY	pH	TDS	CONDUCTIVITY	ACIDITY	ALKALINITY	COD
DAY 1	6.2	53.9	70	40	120	58
DAY 2	5.8	49.2	41	21.3	105	92
DAY 3	5.7	42.4	39	18	92	142
DAY 4	5.6	36.51	35	17.2	65	188

DAY 5	5.6	33.4	32.5	16.5	51.25	161
DAY 6	5.5	20.79	27	15.2	40.75	153
DAY 7	5.4	20.6	26.5	15.6	35.6	139
DAY 8	5.4	20.51	26.1	13.5	31.3	132
DAY 9	5.2	20.3	25.4	12.6	28.7	125
DAY 10	5.2	19.25	25	10	19.25	124

TABLE 1: Chemical analysis of water sample after treated with plant *Canna indica* L.

Phytoremediation of domestic sewage water was done by using the plant *Canna indica* L. Different parameters a showed a gradual decrease after the treatment. The physical and chemical characters worship and absurd during those days of treatment. Temperature of water is an important parameter, which place a vital role in aquatic system. Temperatures always get influenced by external environment. pH explains certain significant biotic and abiotic ecological characteristics of aquatic systems in general. pH balance in an ecosystem is maintained when it is within the range of 5.5 to 8.5 (Chandrasekhar *et al.*, 2003). The Environment Protection Agency of United State's criterion for pH of fresh water aquatic life is 6.5 to 6.9. According to WHO (1998) safe pH limit is 7 to 8.5. But ISI (1991) range is 6.5 to 8.5. A pH range of 6 to 8.5 is normal according to the United States Public Health Association. When compared to all these Standards pH observed in treated waste water which was found within the permissible limit.

Electrical conductivity of water on the first day was higher, but after the treatment with *Canna indica*, there was a significant decrease in the electrical conductivity values. Electrical conductivity of water is dependent upon the concentration of dissolved ions and water temperature. As the concentration of dissolved ions increases, the ability of water to conduct electric current also increased. Electrical conductivity is a basic index to select the suitability of water for agricultural purposes (Kataria *et al*., 1995). EC in water is due to ionization of dissolved inorganic solids and is a measure of total dissolved solids and salinity. (Bhatt *et al*.,1999). Salts that dissolve in water break in to positive charge and negative charge ions. Dissolved solids affect the quality of water used for irrigation or drinking. They also have a critical influence on aquatic biota, and every kind of organism has a typical salinity range that it can tolerate. Moreover, the ionic composition of the water can be critical. These observations pointed out that EC is a highly variable factor in freshwaters. Conductivity is highly dependent on temperature. With decrease in concentration of dissolved ions and water temperature due to treatment with *Canna indica* L. electrical conductivity decreased.

Total dissolved solids content of water are defined us residue which is left upon evaporation at 103 degree celsius to 105 degree Celsius. It is aggregated amount of enter floating, suspended and dissolved solids present in water sample. TDS value concentration of dissolved solids is an important parameter in drinking water and other water quality standards.TDS values exhibited has been decreased after the treatment. Oxygen content is important for direct need of many organisms and affects the solubility and availability of many nutrients and therefore the most significant parameter affecting the productivity of aquatic systems (Wetzel, 1983). DO is the sole source of oxygen for all the aerobic aquatic life and hence it is considered as an important measure of purity for all waters. Also the chemical oxygen demand of water was increased after the treatment with the plant and this indicate the wastewater has undergone to purification. The results showed that the conductivity, turbidity, TDS, DO and alkalinity is above the ISI standard. Other parameters such as pH and COD are below the permissible limit.

Conclusion:

Phytoremediation is a sustainable method for treating kitchen wastewater, according to the results of first and final treatment processes that took into account factors like pH, turbidity, TDS, COD, and BOD. Water quality was found to be improved and kitchen waste water treated with *Canna indica* plants. Over the duration of the experiment, water quality parameters like turbidity, TDS, COD, BOD and TDS revealed a considerable reduction. All along the trial, the pH of the water stayed in the range that was best for plant development and nutrient uptake, showing that the plants could flourish and successfully filter impurities out of the water. This process does not require high energy inputs, maintenance cost. The results of this study suggest that, *Canna indica* plant has the potential to be a cost-effective and environmentally friendly method for treating kitchen waste water. Treated wastewater can be reused for irrigation, washing, flushing tanks, plantation and other purposes.

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