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# Phytoremediation of a eutropic pond Krishnan anaikattu kulam of Pollachi town by *Vetiveria zizanioides* L.

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## ABSTRACT

Krishnan Anaikattu Kulam (KAK) of Pollachi town is a rain fed eutrophic pond polluted by the inflow of municipal sewage, domestic and industrial wastes. An attempt has been made to treat the polluted pond water by the medicinal plant vetiver (*Vetiveria zizanioides* L) belongs to the family as a phytoremedial measure to minimize the pollutant level in eutrophic water. The physico-chemical parameters, nutrient content and growth rate of the pond water after the treatment with vetiver was studied at the intervals of 15, 30, 45 and 60 days. The physical parameters include suspended solids, dissolved solids and total solids. The chemical parameters studied were dissolved oxygen, BOD, COD and total alkalinity. Temperature and pH were stable throughout the period of study. Due to the growth of vetiver the TDS, TSS, and total solids were gradually decreased. The dissolved oxygen content was increased and BOD, COD, total hardness and total alkalinity were decreased. The nutrients such as calcium, magnesium, sodium, nitrate, bicarbonate, calcium carbonate, phosphate potassium and sulphate were reduced due to the activity of vetiver. The growth rate of vetiver was increased enormously was observed.



## KEYWORDS

Phytoremediation;
Physico-chemical parameters;
Vetiveria zizanioides.

## INTRODUCTION

Lakes and ponds rich in nutrients undergo eutrophication, which is the phenomenon of increase of algal blooms and depletion of oxygen in the water. Eutrophicated water leads to the death of aquatic life. Treatment of eutrophicated water has mainly been done by conventional method of water treatment systems such as activated sludge and biological nutrient removal technologies. These technologies are expensive and dependent on electrical energy and skilled personnel. Recently phytoremediation has gained substantial interest in waste water treatment.

Phytoremediation is a green and eco-friendly technology in treating waste water. It is the easiest and cost effective way to reduce the organic and inorganic nutrients in the eutropic water. Plants such as Bamboos, Brassica juncea, Eicchornia crassipes (water hyacinths),

Poplar trees, Alfa alfa, Potomogeton nodosus (American pond weed) and Sagittaria latifolia (Arrow head) and Lycopersicum esculantum (Tomato) are commonly used to treat water polluted with heavy metals and other nutrients.

Vetiver has the unique soil and water conservation properties, erosion control, water disaster mitigation, crop protection, animal feed and medicinal properties. It can be established on acidic and alkaline soils to tolerate high levels of heavy metals in the soil. The vetiver grass becomes an alternative choice to be applied in wastewater remedy because it has complex fibrous root system that can absorb water and elements very well and it can also protect soil surface from soil erosion. In Australia, vetiver was used to absorb leachate and effluent from landfill[10].

Considering the applications of vetiver in soil and water conservation, the present study was attempted to treat the polluted water of KAK pond of Pollachi town with vetiver as a phytoremedial measure.

## MATERIALS AND METHODS

The pond selected for the present investigation, is "Krishnan Anaikattu Kulam" (KAK Pond) and it is situated at 10° 36' N latitude and 77° 03' E longitude at an elevation of 270.09 m above the msl., at a distance of about 4 Km, south west of Pollachi town in Coimbatore district of Tamilnadu state. The KAK pond is a rainfed pond and is highly polluted with municipal sewage, domestic and industrial wastes.

The volume of water was measured before and after culturing vetiver. Three weeks old vetiver slips (*Vetiveria zizanioides*) roughly about 10 cm were taken and cultured in a trough containing 50 liters of pond water. The growth rate was carefully observed and the results were noted at the intervals of 15, 30, 45 and 60 days.

The suspended solids, dissolved solids and total solids were weighed and calculated. The dissolved oxygen in the water samples were analyzed by the Winkler's method[1]. The biological oxygen demand was analyzed by modified Winkler's method (5 days incubation) as per[2]. The chemical oxygen demand was analyzed by Liebig reflex condenser method. The total alkalinity (carbonates and bicarbonates) of the sample was estimated as per the method given by[7].

The dissolved nutrients were estimated by standard methods[2, 5, 8]. The growth rate of the vetiver was also measured in terms of shoot length and root length.

## RESULTS

During the experimental period of about 15- 60 days, it was noticed that there was no significant change in the temperature. In pond water the total dissolved solids was recorded as 1236.46 mg/l and the value was gradually decreased to 600.33 mg/l during phytoremediation with vetiver. Total suspended solids in control water were recorded as 152.7 mg/l. During the treatment the value was reduced to 34.5 mg/l. In control sample, the total solids were recorded as 1388.53 mg/l and the value was decreased to a minimum of 634.53 mg/l during the remediation (TABLE 1 & Figure 1).

**TABLE 1 : Physical parameters of pond water treated with vetiver**

| Physical Parameters/ Period of Exposure | Control | 15 Days | 30 Days | 45 Days | 60 Days |
|---|---|---|---|---|---|
| Temperature (°C) | 30.23 ± 0.20 | 30.23 ± 0.26 | 28.3 ± 0.22 | 29.57 ± 0.21 | 30.53 ± 0.20 |
| Total Dissolved Solids (mg/l) | 1236.46 ± 0.24 | 900.43 ± 0.13 | 725.6 ± 0.25 | 650.57 ± 0.17 | 600.33 ± 0.12 |
| Total Suspended Solids (mg/l) | 152.7 ± 0.16 | 72.47 ± 0.12 | 51.6 ± 0.22 | 40.50 ± 0.27 | 34.5 ± 0.21 |
| Total Solids (mg/l) | 1388.53 ± 0.20 | 972.33 ± 0.16 | 776.4 ± 0.14 | 690.43 ± 0.09 | 634.53 ± 0.29 |

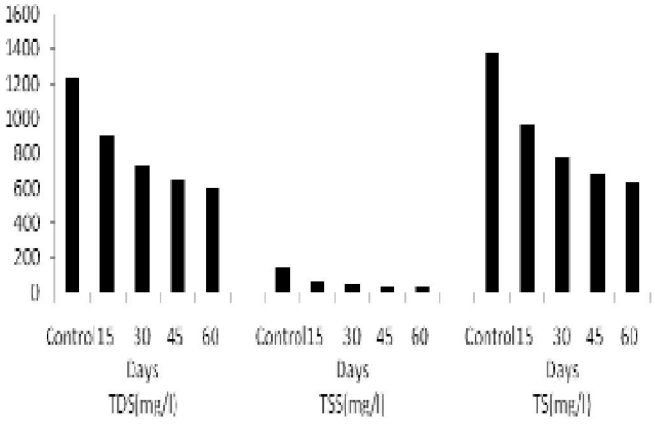


**Figure 1 : Effect of vetiver remediation on the physical parameters (TDS, TSS, TS)**

There was no significant change in the pH during the remediation treatment and the dissolved oxygen was gradually increased from 3.23 mg/l to 5.22 mg/l. The biological oxygen demand of the pond water was 64.54 mg/l. The phytoremediation reduces the BOD values to 10.6 mg/l after 60 days. Before phytoremediation, the COD level was 150.73 mg/l. It was reduced to 31.39 mg/l. The total hardness was gradually decreased from 570.44 mg/l to 520.48 mg/l. The total alkalinity was decreased from 200.72 mg/l to 141.45 mg/l (TABLE 2 & Figure 2-4).

**TABLE 2 : Chemical parameters of pond water treated with vetiver**

| Chemical Parameters/ Period of Exposure | Control | 15 Days | 30 Days | 45 Days | 60 Days |
|---|---|---|---|---|---|
| pH | 7.76 ± 0.11 | 7.67 ± 0.17 | 7.42 ± 0.06 | 7.53 ± 0.02 | 7.45 ± 0.02 |
| DO(mg/l) | 3.23 ± 0.03 | 3.73 ± 0.07 | 4.50 ± 0.10 | 4.86 ± 0.03 | 5.22 ± 0.10 |
| BOD(mg/l) | 64.54 ± 0.24 | 22.53 ± 0.16 | 16.3 ± 0.09 | 12.43 ± 0.17 | 10.6 ± 0.21 |
| COD(mg/l) | 150.73 ± 0.22 | 65.53 ± 0.12 | 43.63 ± 0.20 | 37.52 ± 0.23 | 31.39 ± 0.15 |
| Total hardness (mg/l) | 570.44 ± 0.14 | 569 ± 0.82 | 568.43 ± 0.26 | 542.63 ± 0.13 | 520.48 ± 0.14 |
| Total alkalinity (mg/l) | 200.72 ± 0.46 | 190.42 ± 0.31 | 176.5 ± 0.08 | 153.62 ± 0.11 | 141.45 ± 0.18 |

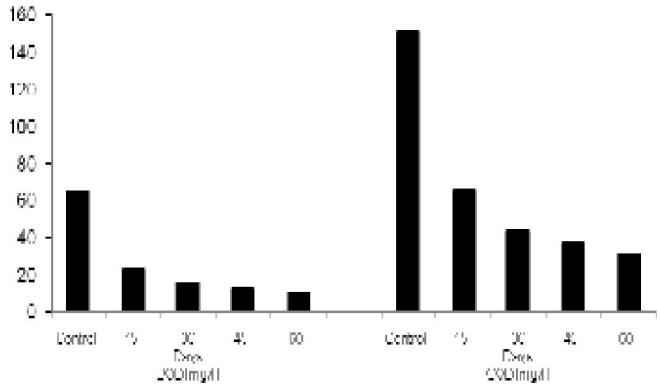


**Figure 2 : Effect of vetiver remediation on the chemical parameters (BOD, COD)**

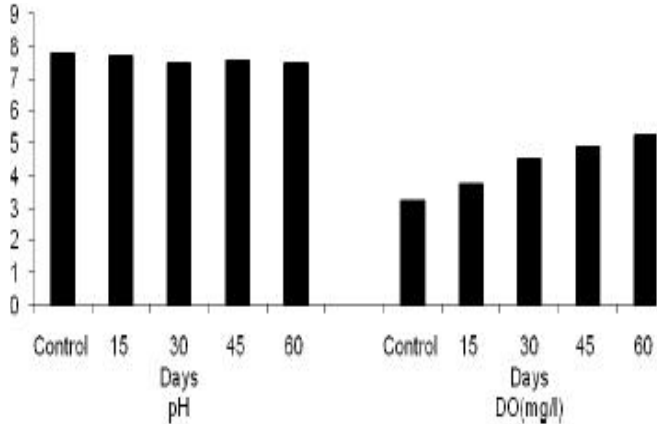


**Figure 3 : Effect of vetiver remediation on the chemical parameters (pH, DO)**

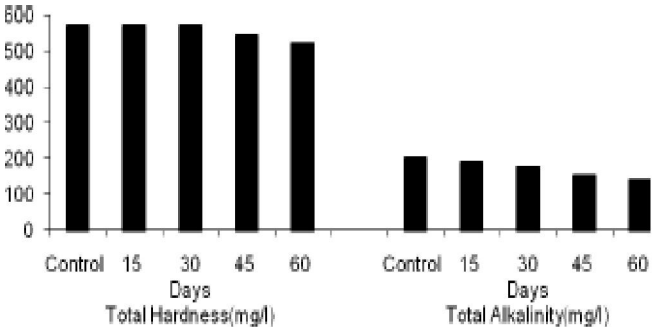


**Figure 4 : Effect of vetiver remediation on the chemical parameters (Total hardness & Alkalinity)**

Calcium level was 100.12 mg/l in the pond sample and it was decreased in vetiver treated water to 62.11 mg/l. The magnesium content was reduced from 98.27 mg/l 48.14 mg/l and the sodium level was found to be decreased gradually from 225.27 mg/l to 39.23 mg/l. The nitrate content of control water was 68.25 mg/l which was reduced to 19.11 mg/l. In control the bicarbonates was found to be 365.43 mg/l which was reduced to 220.26 mg/l. Calcium carbonate was reduced

**TABLE 3 : Nutrients of pond water treated with vetiver**

| Nutrients/ Period of Exposure | Control | 15 Days | 30 Days | 45 Days | 60 Days |
|---|---|---|---|---|---|
| Calcium (mg/l) | 100.12 ± 0.09 | 95.33 ± 0.40 | 88.07 ± 0.05 | 75.37 ± 0.39 | 62.11 ± 0.09 |
| Magnesium (mg/l) | 98.2 ± 0.25 | 80.13 ± 0.05 | 68.12 ± 0.06 | 59.17 ± 0.09 | 48.14 ± 0.05 |
| Sodium (mg/l) | 225.27 ± 0.21 | 115.4 ± 0.33 | 78.4 ± 0.37 | 53.5 ± 0.29 | 39.23 ± 0.26 |
| Nitrate (mg/l) | 68.25 ± 0.14 | 46.42 ± 0.30 | 30.25 ± 0.14 | 23.14 ± 0.13 | 19.11 ± 0.08 |
| Bicarbonate (mg/l) | 365.43 ± 0.27 | 349.27 ± 0.25 | 320.33 ± 0.47 | 280.14 ± 0.05 | 220.26 ± 0.25 |
| Calcium carbonate (mg/l) | 250.11 ± 0.09 | 224.98 ± 0.43 | 189.18 ± 0.13 | 160.11 ± 0.09 | 145.14 ± 0.05 |
| Phosphate (mg/l) | 2.7 ± 0.08 | 2.64 ± 0.04 | 1.92 ± 0.02 | 1.33 ± 0.03 | 1.00 ± 0.01 |
| Potassium (mg/l) | 79.13 ± 0.03 | 56.15 ± 0.05 | 30.18 ± 0.11 | 22.2 ± 0.22 | 18.07 ± 0.05 |
| Sulphate (mg/l) | 110.13 ± 0.01 | 98.1 ± 0.08 | 79.07 ± 0.05 | 65.10 ± 0.08 | 59.18 ± 0.18 |

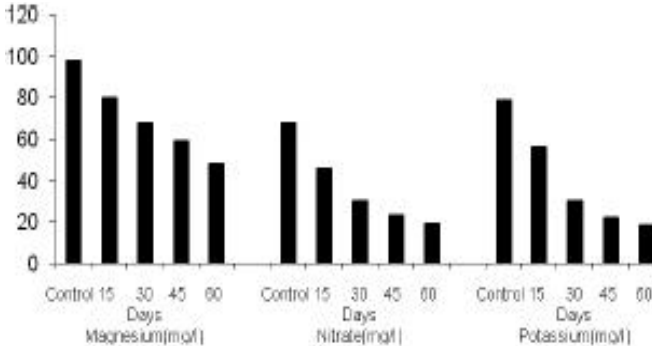


**Figure 5 : Effect of vetiver remediation on the nutrients (Magnesium, Nitrate, Potassium)**

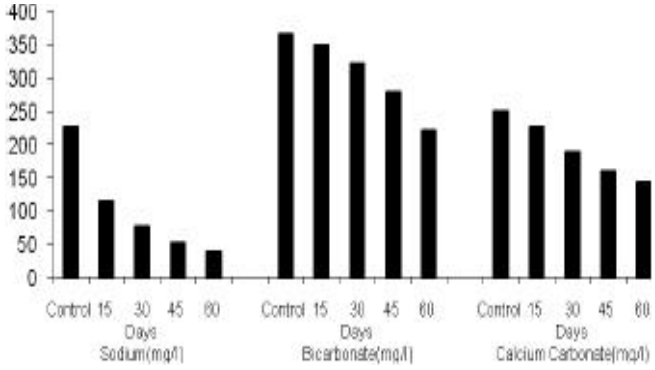


**Figure 6 : Effect of vetiver on the nutrients (Sodium, Bicarbonate, Calcium carbonate)**

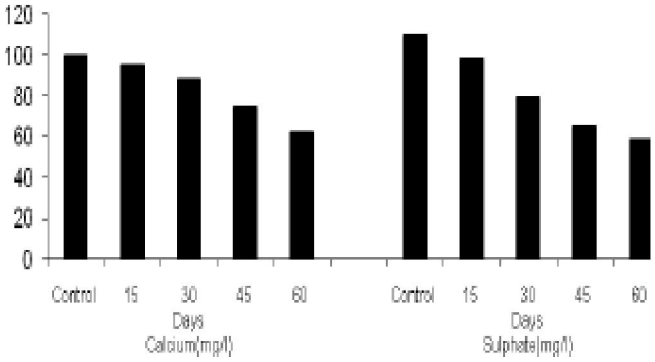


**Figure 7 : Effect of vetiver remediation on the nutrients (Calcium, Sulphate)**

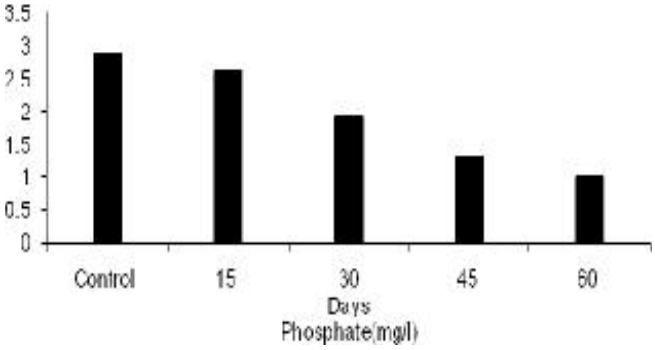


**Figure 8 : Effect of vetiver remediation on the nutrients (Phosphate)**

from 250.11 mg/l to 145.14 mg/l. The phosphate content was recorded as 2.7 mg/l in control whereas it was reduced to 1.00 mg/l. The potassium level was decreased from 79.13 mg/l to 18.07 mg/l. Sulphate content was also reduced from 110.13 mg/l to 59.18 mg/l (TABLE 3 & Figure 5-8).

The growth rate of vetiver plants increased in terms of shoot and root length. The shoot length was increased from 10.14 cm to 66.21cm and root length from 4.80 cm to 8.38 cm. The volume of water gradually decreased from 50.41 to 30.41 litres during the phytoremediation treatment with vetiver for about 60 days (TABLE 4 & Figure 9).

**TABLE 4 : Growth rate of vetiver cultured in polluted pond water**

| Growth rate/ Period of Exposure | Control | 15 Days | 30 Days | 45 Days | 60 Days |
|---|---|---|---|---|---|
| Volume of water (lit) | 50.41 ± 0.42 | 45.5 ± 0.17 | 40.51 ± 0.18 | 35.42 ± 0.13 | 30.41 ± 0.11 |
| Shoot length (cm) | 10.14 ± 0.06 | 23.87 ± 0.49 | 40.15 ± 0.32 | 56.04 ± 0.18 | 66.21 ± 0.38 |
| Root length (cm) | 4.80 ± 0.10 | 5.90 ± 0.02 | 6.68 ± 0.16 | 7.70 ± 0.11 | 8.38 ± 0.07 |

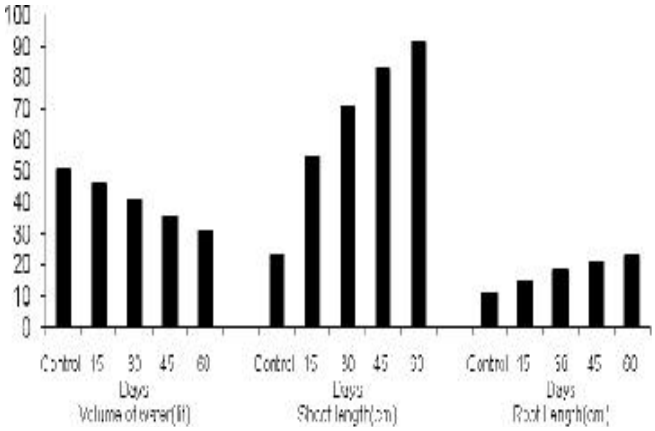


**Figure 9 : Growth rate of vetiver plant cultured in pond water**

## DISCUSSION

Chomchalow(2006)[3] stated that total suspended solids, BOD and nutrients like nitrate, bicarbonate, potassium and sodium decreased and the efficiency of waste water treatment was found to increase with the age of vetiver plant after three months. In the present study also total suspended solids, BOD and the nutri-

ent contents like calcium, magnesium, sodium, nitrate, bicarbonate, calcium carbonate, phosphate, potassium and sulphate were decreased enormously in accordance with the above findings.

The dissolved oxygen increased due to the vetiver treatment whereas the BOD and COD values decreased drastically. The pH of the water was unchanged throughout the period of study[11]. Studied waste water management by using grasses to solve the disposal problem and to improve quality of wastewater discharged from communities where he showed the decrease in BOD value and increase in the DO and pH values. This shows the unheard ability of the grasses to absorb and tolerate extreme levels of nutrients[4]. Found that vetiver and *Cyperus alternifolius* reduces the high COD, BOD, ammoniacal nitrogen and total phosphate in pig farm waste water to a larger extent with Hydraulic Retention Time (HRT) of 4 days.

Zheng *et al*.(1997)[12] found that vetiver can remove soluble phosphate upto 99% after three weeks and 74% of nitrogen after five weeks[9]. Practised a hydroponic system of vetiver culture using sewage effluent to remove the nitrogen and phosphate over 90% and also reduced the algal growth and faecal coliforms. According to them a single vetiver plant can consumes an average of 1.1 liter of water daily.

According to[6] due to the increase in the length and number of rootlets, the root system will absorb dissolved elements and collect it in the root system. In the present study the growth rate of vetiver plant cultured in the polluted water was increased interms of both shoot length and root length.

In the present investigation it is clear that vetiver is a very efficient and low cost method for treating effluent and leachate from both domestic and industrial sources. This system when properly designed and applied will certainly play a key role in minimizing the impact of the imminent global clean water shortage.

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