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Original Research Article

Assessment Studies on River Pollution by Textile Dyes and Heavy Metals around Bhavani-Komaraplalaya, Tamilnadu, India

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Abstract	Keywords
<p>The effect of textile dye effluent on morphology and growth pattern of <i>Zea mays</i> L. in different concentrations has been studied. For this research work the samples from Kaveri river near Bhavani area were taken and analysed for BOD, COD, EC, pH and concentration of reactive red (R-red) and reactive black (R-black) textile dyes. The BOD at 27°C, for 3 days was observed to be 92 mg/l. The COD level was very high (2325 ppm), and the EC was 13 mS/cm at 25°C R-red dye concentration was 242 ppm and absorbance was 0.791. R-black dye concentration was 301 ppm. pH ranged from 4-7. Chemical analysis was found to be far away from EPA standard of potable water. The high values of the parameters BOD, COD, pH and EC demands pretreatment of the effluent before its discharge into water bodies. Also, the high conductivity observed shows that sufficient ions are present in the effluents, thus suggesting that the chemical method of treatment may be suggested. In 10% of effluent the growth pattern was not noticeable. The effluent concentration of 20% was supporting the growth of maize plants with improved biomass.</p>	<p>Bioaccumulation Biosorption Phytoremediation <i>Zea mays</i></p>

Introduction

The Kaveri River originates in the Brahmagiri hills of the Western Ghats near Coorg (Kodagu). Its total course of 770 km commands a basin area of 8.8 mha (56% in Tamilnadu, 41% in Karnataka and 3% in Kerala). With three major reservoirs, a number of weirs and anicuts built across the river and its tributaries, Kaveri is the most exploited river of the

country (95% abstraction of water).the main polluters are agricultural, industrial and urban sectors. Huge quantities of fertilisers and pesticides are discharged into the river as agricultural runoff. Coffee plantation in the districts of Kodagu, Hassan and Chikmagalur contributes heavily to BOD level (about 4,730 tons load in each season) in the river water which ranges

between 2000 to 4000 mg/l. A total of 61 industries in Karnataka and 1,139 in the Tamilnadu contribute a heavy pollution load. These include water intensive textile and sugar units, paper mills, chemical units, engineering units and tanneries. The quantity of wastewater discharged directly into the river is approximately 87,600 cu m/day. The river has a total dissolved solid (TDS) level of 1,450 mg/l which is three times higher than the permissible limit of 500 mg/l prescribed by the WHO (1992).

The textile industries use large volumes of water in their operations and therefore discharge large volume of wastewater into the environment, most of which is untreated and there are many options for treating them (Vandevivere et al., 1998). The wastewater contains a variety of chemicals from the various stages of process operations which include desizing, scouring, bleaching and dyeing. The textile industry is distinguished by the raw material used and this determines the volume of the water required for production as well as the wastewater generated. The production covers raw cotton, raw wool and synthetic materials. The industries studied in the present report are raw cotton based. In this type of production, slashing, bleaching, mercerizing and dyeing are the major sources of the waste water generated (Tüfekci et al., 2007).

Eichhornia, water hyacinth, is a genus of aquatic flowering plants in the family Pontederiaceae widely utilized for phytoremediation. The genus is native to South America. *Eichhornia crassipes* has become widely naturalized in tropical and subtropical regions and is a significant invasive species. The common water hyacinth (*E. crassipes*) is vigorous growers known to double their population in two weeks. The plant is extremely tolerant and has a high capacity for, the uptake of heavy metals, including cadmium, chromium, cobalt, nickel, lead and mercury, which could make it suitable for the biocleaning of industrial wastewater in addition to heavy metals, *E. crassipes* can also remove other toxins, such as cyanide, which is environmentally beneficial in areas that have endured gold mining operations (Alvarado et al., 2008; Saraswat and Rai, 2010).

The textile industries are very complex in nature as far as varieties of products, process and raw materials are concerned. During production, the cloth has to pass through various processes and chemical operations like sizing, desizing, scouring, mercerising, bleaching,

dyeing, printing, and finishing. In a textile industry, a number of dyes chemicals and auxiliary chemicals are used to impart desired quality in the fabrics. The wastewater of the industry is highly alkaline in nature and contains high concentration of BOD, COD, TDS and alkalinity. It contains toxic load of heavy metals and dyes reactive red and black. It can cause environmental problems like soil pollution and water pollution which makes the water unfit for agriculture and drinking purposes. The objectives of the study were: (1) to collect data on the effluent load being discharged from textile processing units for the various operations requiring water (bleaching and dyeing); (2) to understand the current treatment and disposal practices and the implication of the same on ground and surface water; (3) to analyze heavy metal status and textile dye pollution of Kavery river and to discuss suitable bioremediation methods.

Materials and methods

Study site: Bhavani is a second grade municipality in Erode district, Tamil nadu, India. It is situated at the north of Erode city and it is about 107 km (66 mi) from Coimbatore city on national highway 47. Bhavani is also known as the carpet city, as the leading business of the town is known for its carpet industry. Bhavani is located at 11.45°N 77.68°E. It has an average elevation of 193 meters (633 feet). Kooduthurai, or Mukkoodal is a holy place situated in Bhavani urban area near the agglomeration of Erode, Tamil Nadu.

The physico-chemical and heavy metals considered in the present study were analysed from different effluent water samples of textile industries in the study sites described above using standard procedures (APHA, 2005). Bacterial isolates were isolated through enrichment and then tested for their potential to remove reactive black and red dye in liquid medium in different concentrations of effluent. Two bacterial isolates capable of degrading black-b azo-dye efficiently were screened through experimentation on modified medium. Present investigation was carried out to assay the effects of industrial effluents treated on maize (*Zea mays*). The concentrations used for the effluents were 0, 10, 20 and 40% respectively.

Results and discussion

The pure effluent is analyzed for its chemistry and it indicates typical feature of water pollution. The higher

concentration of BOD and COD is notable, and lethal to plants and animals. The pure effluent kills the *Eichhornia* plant which shows the symptoms of death of plant organs. After 10, 20, 30 and 40% dilutions, the effluent favoured the growth. The plant can degrade the azodyes up to 10 ppm for 10, 20 and 30 h of phytoremediation (data not given). The pure effluent is collected, and stored in corked bottles and analysed for BOD, COD, EC, pH and concentration of R-red and R-black textile dyes. The BOD at 27°C, 3 days was 92 mg/l or ppm. The COD level was very high indicates 2325 ppm, the EC was 13.0 mS/cm at

25°C. R-red dye concentration was 242 ppm. R-black dye concentration was 301ppm. pH ranged from 4-7. The chemical analysis was found to be far away from EPA standard of potable water. Physicochemical characteristics of these effluents revealed that both of them contained high amounts of sulphates, nitrates, calcium, various heavy metals, etc., which confirms their highly polluted conditions. Seed germination in pure effluent was 30%. In 10% of effluent the growth pattern was not noticeable. The effluent concentration of 20% was supporting the growth of maize plants with improved biomass (Table 1).

Table 1. Response of *Zea mays* to water with textile effluent treated with *Eichhornia*.

Parameter	Control	Effluent concentration			
		100%	10%	20%	30%
First day					
Germination (%)	100	Nil	4.0	3.0	2.0
Root length (cm)	1.5		2.0	2.1	2.3
Shoot length (cm)	2.0		2.2	2.2	2.4
Leaf (no.)	1.5		2.2	2.3	2.6
Biomass (g)	2.0		2.4	2.6	2.8
Second day					
Germination (%)	100	Nil	4.0	3.0	2.0
Root length (cm)	1.5		2.3	2.4	2.6
Shoot length (cm)	2.0		2.5	2.6	2.9
Leaf (no.)	1.5		2.4	2.7	2.9
Biomass (g)	2.5		2.8	2.9	3.1
Third day					
Germination (%)	100	Nil	4.0	3.0	2.0
Root length (cm)	2.0		2.5	2.6	2.8
Shoot length (cm)	3.0		2.5	2.7	3.2
Leaf (no.)	2.0		2.6	2.7	3.2
Biomass (g)	3.0		3.2	3.5	3.7
Fourth day					
Germination (%)	100	Nil	4.0	3.0	2.0
Root length (cm)	2.5		2.7	2.8	3.2
Shoot length (cm)	3.5		2.8	2.9	4.2
Leaf (no.)	2.6		2.9	3.0	3.6
Biomass (g)	3.7		3.8	3.9	4.3

Maximum improvement in seedling length was found in 30% of textile effluent. Lower concentrations enhanced the growth. Number of leaves was unaffected and remained same in all concentrations of the two effluents. This study indicates pollution that prevent germination certain level and growth pattern after 40%. Phytoremediation, being more cost-effective and fewer side effects than physical and chemical approaches, has gained increasing popularity in both academic and practical circles. More than 400 plant species have been identified to have potential for

soil and water remediation. Among them, *Thlaspi*, *Brassica*, *Sedum alfredii* and *Arabidopsis* species have been mostly studied. The textile industry consumes large quantities of water and produces large volumes of wastewater through various steps in dyeing and finishing processes. The textile waste water is a complex and variable mixture of polluting substances like inorganic, organic, elemental and polymeric products (Brown and Laboureur, 1983). Among complex industrial wastewater with various types of colouring agents, dye wastes are predominant.

Due to low biodegradation of dyes, convectional biological treatment process is not very effective in treating dye wastes. Vasanthy et al. (2011) removed the textile dyes red RB and black B from their aqueous solutions by water hyacinth plant material. The efficiency of *E. crassipes* to remove the colour and degrade the dye was about 95% with red RB and 99.5% with black B. The authors observed the changes in phytochemical components by GC-MS analysis before and after adsorption, where increased content of hexadecanoic acid and reduced phytol content were reported. The use of industrial waste water for irrigation purposes has emerged an important way to utilize its nutrients and removal of its pollutants load by growing tolerant plant species.

Conclusions

From the analysis, the textile effluent was found to have high pH indicating alkalinity of the sample and large amounts of total suspended (TSS) and total dissolved solids (TDS), minerals and metals like sodium, potassium, chromium, zinc, copper etc. The results of biometric observations showed that the maize plants grown under 10, 20 and 30% concentrated effluent were taller than the plants grown in water (control). The seeds did not germinate when the undiluted effluent was used as such for irrigating the plants. Potassium, copper, chromium, cadmium, nickel and zinc were found to be more accumulated in the leaves of the plants treated with 25% dilution effluent. This indicates the accumulation potential of leaves and roots when they are grown using effluent with high dilution.

Heavy metal contamination of vegetables cannot be underestimated as these food stuffs are important components of human diet. Vegetables are rich sources of vitamins, minerals, and fibers, and also have beneficial antioxidative effects. However, intake of heavy meta-contaminated vegetables may pose a risk

to the human health. Heavy metal contamination of food is one of the most important aspects of food quality assurance.

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