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Treatment of sewage waste water using water hyacinth - *Eichhornia* sp and its reuse for fish culture

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Abstract

The absorption of heavy metals like chromium, copper and zinc present in the sewage waste water using aquatic plant, water hyacinth - *Eichhornia* sp were studied. The experimental setup (100% untreated and treated sewage samples) was prepared and the water hyacinth plants were introduced into the tubs. After 96 hrs, sewage samples were analysed and the results showed an active reduction in physicochemical parameters and heavy metals. The biotreated sample was reused for Aquaculture of fish - *Tilapia mossambica* for a period of 60 days. The growth study was carried out and the maximum growth was recorded in biotreated samples. After the growth study, the histology procedures were carried out on the target organs such as brain, gills, liver and muscles. The histology and histopathology results revealed the degeneration of nerve cells, fusion of secondary lamella of gills, vacuolization of hepatocytes, swelling and longitudinal splitting of muscle fibres were seen in 100% untreated and treated sample but the 100% biountreated and biotreated sample resembled as like control animals.

Keywords: Sewage waste water, water hyacinth - *Eichhornia* sp, physicochemical parameters, *Tilapia mossambica,* growth, histopathology.

Introduction

Water, land and air are the fundamental media in which life exists. The pollution causing adverse effects on physical, chemical and biological factors of water bodies is known as water pollution (Sathyanarayanan, 2007). The waste water resulting from domestic, agricultural and industrial activities are technically referred to as sewage. The sewage is mostly composed of toxic substances, heavy metals and pathogenic organisms (Athalye *et al.,* 2001). Sewage contains about 99% of water and 1% of solids. When untreated domestic sewage and industrial effluents are released into surface water bodies it creates serious water pollution. Toxic heavy metals like zinc, copper, chromium, lead and cadmium present in the sewage are mostly absorbed and get accumulated in various plant parts as free metals, these free metals gets transferred in the food chain and finally reach man who is at the top of all the food chains. The toxic metals may adversely affect the normal growth and metabolism (Barman and Lal, 1994). In most cases the domestic sewage is discharged as such in the form of untreated, treated or partially treated into the nearby water bodies, where it can cause severe sanitary and other water pollution problems. Hence it is very important to treat sewage waste water before its disposal (Sathyanarayanan, 2007). Degradation is a technique to degrade rapidly hazardous organic contaminants to environmentally safe levels in soils, waters sludges and residues by using microorganisms, plants and animals (Goel, 1997).

As alternatives, slowly biological tools are being substituted in pollution abatement programs. This new technology has been grouped together under the term "Bioremediation". The use of specially selected and engineered pollutant - accumulating plants for environmental cleanup is an emerging technology called phytoremediation. Phytoremediation works best at sites with low to moderate amount of pollution, and at sites contaminated with metals. Water hyacinth has been successfully applied not only in removing organics and metals but also act as a bioindicator for assessment of metal pollution (Prakasham *et al.,* 1998). It is seen that water hyacinth has a tremendous capacity of absorbing metals like copper, cadmium, zinc, iron, mercury, arsenic

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and lead (Panda, 1996). There is shortage of water throughout the world. Therefore, there is a need for recycling of waste water i.e., the use of reclaimed waste water whenever possible (Goel, 1997). Recycled waste water is currently used for aquaculture (Paulami, 2002). Fishes are important aquatic animals and are particularly sensitive to wide variety of toxicants. Fishes are bioindicators of metal pollution in particular and industrial pollution in general. Hence this study is focused on the treatment of sewage waste water and reuse of treated water for aquaculture using fish - *Tilapia mossambica* for a period of 60 days and to elucidate the changes in the different target organs like brain, gills, liver and muscle with reference to histological and histopathological studies.

Material and Methods

Untreated and treated sewage waste water were collected from the sewage treatment plant situated in Koyembedu, Chennai, Tamilnadu, India, in polythene containers (5 litres capacity). Water hyacinth *Eichhornia* sp plants of similar size were harvested from the Chetpet Pond, Chennai. The plants were washed thoroughly and maintained in tap water for 10 days to acclimatize to laboratory conditions. The fingerlings of fish *Tilapia mossambica* were brought from the hydrobiological research station, Tamilnadu Fisheries Department, Chetpet. The fishes were acclimatized for a period of 10 days and were fed with pelletised feed daily and sufficient oxygen was maintained by an aerator.

The physico-chemical parameters of sewage waste water such as colour, odour, pH, EC, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Biological Oxygen Demand $(BOD)_5$, Chemical Oxygen Demand (COD) and heavy metals such as Chromium, Copper and Zinc present in the sewage samples were studied following the Standard methods outlined by APHA (1995) before and after introduction of the water hyacinth plants in the sewage waste water samples. Batch experiments were conducted in 4 plastic tubs (15 litres capacity). The outer surface of the tubs was covered with black polythene papers to prevent entry of excessive light from the sides. The initial level of physico-chemical parameters and heavy metals in the sewage waste water samples were estimated in the Atomic Absorption Spectrophotometer (AAS) as per the procedure of Kannagi (2007). The fishes ranging from 4-7 cms in length and body weight of 2-4 gms were introduced in 10 litres of 100% untreated, treated, biountreated (after treatment of untreated sample with *Eichhornia* sp) and biotreated (after treatment of treated sample with *Eichhornia* sp) sewage samples separately. The growth study of fish *Tilapia mossambica* were conducted using biotreated and biountreated samples in terms of length, breadth and weight and were estimated for a period of 60 days by following the procedure of Periyaswamy (1999). After the growth study of fishes in different sewage samples, the histological studies were carried out, as histology is used as an index of fish health status. The organs selected for histopathological studies were brain, gills, liver and muscle. The organs were removed and fixed in natural form for about 24 hours, processed and stained with Erhlich's haematoxylin and Eosin Y stain as per the procedure of Pearse (1980 and 1995).

Results and Discussion

The physicochemical parameters of sewage sample were carried out before and after the introduction of water hyacinth plants and the results of the same are shown in Table-1. Colour, odour, pH, EC, TSS, TDS, BOD, COD and heavy metals of sewage samples were found to be higher than the permissible limits of CPCB (1995) before the introduction of water hyacinth plants but at the end of 96 hrs, maximum reduction of BOD (Biountreated 83.33% and Biotreated 80%), COD (Biountreated 78.93% and Biotreated 88.69%) and Heavy metals such as Chromium (Biountreated 84.74% and Biotreated 100%), Copper (Biountreated 87.21% and Biotreated 89.43%), Zinc (Biountreated 99.07% and Biotreated 100%) were recorded using water hyacinth plants. The present study was further extended to reuse the biountreated and biotreated sewage water for culturing the fish *Tilapia mossambica*. The results of the growth study are represented in Table-2. Overall increasing trend were recorded in all the samples especially, maximum growth of fish was recorded in biotreated samples.

The normal histological nature and the remarkable histopathological changes due to

Table 1: Physicochemical characteristics of sewage waste water before and after treatment using *Eichhornia* sp.

Sl. No.	Characteristics	Permissible Limits (CPCB, 1995)	Before Treatment		After Treatment using *Eichhornia* sp (at the end of 96 hrs.)		Percentage removal	
			Untreated	Treated	Biountreated	Biotreated	Biountreated	Biotreated
1.	Colour	Colourless	Grayish Black	Brown	Colourless	Colourless	–	–
2.	Odour	Odourless	Offensive	Earthy	Odourless	Odourless	–	--
3.	pH	5.5 - 9.0	6.7	5.7	6.9	7.0	–	–
4.	EC (μmhos/cm)	400	1944	1485	623	402	67.94%	72.92%
5.	TSS (mg/l)	100	157	121	9	7	87.89%	95.21%
6.	TDS (mg/l)	2100	1386	1242	466	362	66.95%	70.85%
7.	$(BOD)_5$ (mg/l)	30	210	145	35	9	83.33%	80%
8.	COD (mg/l)	250	622	230	131	26	78.93%	88.69%
9.	Chromium (mg/l)	2	0.00943	0.00550	0.00118	Nil	84.74%	100%
10.	Copper (mg/l)	3	0.1998	0.00871	0.02554	0.00092	87.21%	89.43%
11.	Zinc (mg/l)	1.5	0.152	0.00141	0.00141	Nil	99.07%	100%

Table - 2 : Growth study of fish *Tilapia mossambica* for a period of 60 days using biountreated and biotreated sewage water.

Sl. No.	Days	Control (Tap Water)			Untreated			Biountreated			Treated			Biotreated		
		L (Cms)	B (Cms)	Wg (Gms)	L (Cms)	B (Cms)	Wg (Gms)	L (Cms)	B (Cms)	Wg (Gms)	L (Cms)	B (Cms)	Wg (Gms)	L (Cms)	B (Cms)	Wg (Gms)
1.	O Day	6.0	2.0	3.0	6.0	2.0	3.0	6.0	2.0	3.0	6.0	2.0	3.0	6.0	2.0	3.0
2.	10th Day	7.5	2.5	5.6	6.3	2.1	3.2	7.4	2.4	5.1	7.2	2.3	5.2	7.7	2.5	5.8
3.	20th Day	7.9	2.8	7.5	6.5	2.3	3.8	7.6	2.5	7.3	7.5	2.5	7.2	7.9	2.7	7.5
4.	30th Day	8.1	3.0	10.1	7.0	2.5	5.3	7.9	2.6	9.4	7.7	2.7	7.3	8.0	2.9	10.0
5.	40th Day	8.3	3.1	10.9	7.1	2.6	6.7	8.0	2.9	10.2	8.1	2.9	7.9	8.2	3.2	10.8
6.	50th Day	8.5	3.3	11.6	7.3	2.8	7.1	8.3	3.1	10.3	8.2	3.0	10.1	8.4	3.3	11.2
7.	60th Day	8.8	3.4	13.7	7.7	2.9	7.8	8.4	3.6	10.4	8.3	3.2	10.3	8.7	3.4	13.5

L = Length (cms), B = Breadth (cms), Wg = Weight (gms)

exposure in the brain, gills, liver and muscle are observed. The overall results recorded in this study indicates that more severe histopathological changes have been found in all the tissues of 100% untreated and treated samples and mild changes were observed in the 100% biountreated and biotreated samples. Brain is a vital organ in the body and it is supposed to be the last organ to be damaged by pollutants as it has more protective mechanisms such as blood-barrier system that prevents the direct flow of substances through the blood to the brain (Padmaja, 1989). The brain of fish exposed to sewage samples shows degeneration of nerve cells, vacuolation and necrosis of the brain cells. Many aquatic pollutants were assayed for their deleterious effects on the cellular ultrastructure of the gills epithelium (Bunton and Poynton, 1991). The secondary lamellae were thin and were fused together. Erosion of mucus cells, epithellial cells, degeneration of pilaster cells were noticed. Liver is the centre for metabolism and detoxication in piscine body. The necrosis, degenerative changes and infilteration of blood cells into the hepatocytes were mainly observed in the liver of tested fish. This is in agreement with the work of Kothari and Suneetha (1990). Cloudy swelling of muscle fibres accompanied by the disappearance of the striations was observed in the muscle of *T .mossambica*. Maximum degenerative changes were observed in different organs of *T. mossambica* exposed to 100% untreated and treated sewage samples compared to control and mild histological changes were observed in organs of fish exposed to 100% biountreated and biotreated sample.

In conclusion, the present investigation demonstrates the feasibility of adopting a "sustainable" and eco-friendly approach to sewage waste water treatment using aquatic plant *Eichhornia* sp emphasizing on degradation and recycling/reuse of sewage water for biocompost production of irrigation and aquaculture. Since this is only a laboratory scale base - line study, further investigations should be carried out in future on a large scale particularly focusing on phyto-remediation and resource utilisation.

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