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"Eco – Environmental Study on Nutrient Removal Potential of Eichhornia Crassipes from Domestic Wastewater"

* D. K. Patel ** V. K. Kanungo

*,** G. G. V. (A Central University), Bilaspur (C.G.), Govt. College of Science, Raipur (C. G.), India

ABSTRACT

Eichhornia crassipes was studied to ensure its capability of nutrient removal from domestic wastewater treatment. Untreated domestic wastewater with excess nutrients leads to eutrophication in fresh water bodies, causing unhygienic to use of water and foul smelling. Floating aquatic plants are well situated to treat biodegradable wastewater.

The study was carried out to prevent early eutrophication by culturing Eichhornia crassipes in a tub of 0.173 m diameter, six inches deep and 20 Liter capacities; second one tub of the same was used as control. After filling of domestic wastewater, 100gm fresh biomass of Eichhornia crassipes was cultured and experimental observation was seen in one week interval, in each month of the study period of one year. Qualitative examination of domestic wastewater was determined before and after seven days culture of Eichhornia crassipes in domestic wastewater by various physico-chemical parameters following APHA-AWWA- WPCF, (1980), Trivedy, R. K. and Goel, P. K., (1984).

Results of domestic wastewater quality showed that reduction in the values of most of the parameters after the experiment, Except of pH and Dissolved oxygen.

In experiment, increased biomass of Eichhornia crassipes was noticed and used in Net primary productivity determination.

Keywords : Physico-chemical analysis, Domestic wastewater, Net primary productivity

INTRODUCTION

Domestic wastewater disposal without any proper treatment creates an environmental problem in aquatic system. Continuous releasing a huge amount of domestic wastewater leads to water quality degradation as forming eutrophication. Domestic wastewater consistently higher concentration of nitrogen, phosphorous etc. The treatment and disposal of domestic wastewater had posed a problem in recent time for municipalities. The growing population has increased the per capita demand of water and due to non availability of proper disposal system domestic wastewater discharged in low lying area generally through earthen channel. Climate at the specific area and habits of the people have a marked effect on the wastewater characteristics.

Concentrations are also effected by the amount of water used by per person. Thus, domestic wastewater characteristics vary not only from city to city but also from season to season even hour to hour. Domestic wastewater contain significant amount of nutrients like Nitrogen, phosphorous etc. therefore removal of these nutrients has become an important aim for wastewater treatment.

Despite knowing the severity of harmful effects, domestic wastewater with rich nutrient load is disposed because of the higher cost of the treatment. Water hyacinth has been utilized successfully in wastewater treatment system for reduction of various organic and inorganic nutrients Wastewater treatment using varied aquatic plants were carried out by researchers like Boyed, 1970, Wooten et al, 1979, Abbasi and Nipany, 1985, Brix, 1989, Debusk, 1989, Karpiscak et al, 1994, El – Gendy et al, 2005, Zimmles et al, 2006. (Brix, 1993, Delgado et al, 1995.

A number of researches have been done for potential examination of aquatic plants to trace out heavy metals from polluted wastewater like Wolverton et al,1979, Briex and Schierup, 1989, Delgado, 1993,Dirilan and Inel,1994, Rai et al, 1995 also for reduction of heavy metals in drainage water. The *Eichhornia crassipes* competitive success seems also to be related to the level of eutrophication and the area occupied by the rest of the vegetation present in the habitat. Nutrient removal by aquatic plants in constructed wetlands and artificial ponds is of great significance which applied to control early eutrophication of wastewater sites. Constructed wetlands for wastewater treatment were suggested like Oron et al, 1987, Hammer, 1992, Brix, 1993, Zakova et al, 1994. An aquatic plant removes nutrients from wastewater by absorbing and incorporating in their body system. Removal rates depend on age and species of aquatic plant, their versatility, stability, quality of water, tolerance capacity to environment and plant physiological speciation. Utilization of aquatic plants for removal of various nutrients from wastewater was examined by Sutton and Orens, 1975, Carnell et al, 1977, Dings, 1978, Rai and Datta, 1978, Wolverton and Donald 1979, Abbasi and Nipeny, (1985). Goal et al ,1985, Reddy and Debusk, 1985, Brix and Schirup, 1989, Chandra et al, 1993, Mandi,1994, Aoi and hayashi, 1996, Saha and Jana,2002, Sooknah and Wikie, 2004, Shobha and Harilal,2005, Janijit et al, 2007. Main objective of the present research is to examine nutrient removal potential of *Eichhornia crassipes* from domestic wastewater.

MATERIALS AND METHODS

(1). Experimental design:

Nutrient removal from domestic wastewater by *Eichhornia crassipes* was carried out. The experiment consists of two tubs of 0.173m diameter, six inches deep and 20L capacity. Primarily both tubs were filled with domestic wastewater selected from major drainage of Raipur (C.G. – India). One set of experimental tub was used as control and second one was utilized in culturing fresh biomass of 100 gm *Eichhornia crassipes* for the duration of seven days, which was collected from a pond at Raipur. 100 gm young individuals were taken for further experiment.

(2). Sample analysis:

On starting of the experiment (Before culture of *Eichhornia crassipes*) and after seven days of experiment, Physico-chemical quality was assessed by various physico-chemical parameters (Instrumental analysis was applied for Physical examination of domestic wastewater whereas chemical parameters were determined by titration and by using spectrophotometer. Some parameters like Total carbon dioxide, Percentage oxygen saturation, Magnesium and Organic phosphate were calculated by formula), following APHA-AWWA-WPCF, (1980).

(2). Biomass (NPP) determination:
Increased biomass after seven days of experiment was also recorded in complete research tenure following Trivedy and Goel, (1984), Chemical and biological methods for water pollution studies.

RESULTS AND DISCUSSION
Variable Physico-chemical characters of domestic wastewater before and after the culture of *Eichhornia crassipes* given in table-1, table - 2 showing variation in net primary productivity throughout the study period. Table – 3 Indicating summarized form of domestic wastewater data before culture of experimental aquatic plant and % changes after seven days of experiment. The impact of *Eichhornia crassipes* on Physico-chemical characteristics of water is general are decline in Tem, BOD and nutrient levels (Rainad D. N., Datta Mushi, 1979).

(1). Physical changes:
Due to increasing biomass of Eichhornia crassipes Temperature were always reduced after seven days of culture. Temperature and light impact on water hyacinth reported by Olga and Alenka, 1989. pH values at the end of experiment shifted towards few basic range. Eichhornia crassipes showed maximum growth (Number of plants and dry weight) at pH 7.00, with 2 – 3 pH being toxic to plant 4.2 – 4.5 possibly inhibitory. (Brix, 1997). Turbidity and Salinity values were reduced. Salinity effect on growth of aquatic vegetation was studied by Haller et al, 1997. Electrical conductivity and Total dissolved solids related to each other were found to reducing trend at the end of experiment.

(2). Chemical changes:
Alkalinity, Free corbondioxide, Total corbondioxide values (mg/L) were reduced after the experiment and values were ranged initially 235.5 - 377.5, 28.02 – 168.16 and 239.22 – 436.56 respectively.

In polluted domestic wastewater Dissolved oxygen value (mg/L) ranged 1.4 – 5.5 before culture of *Eichhornia crassipes.* Due to successful photosynthetic activity the aquatic plant adds significant amount of oxygen in to water through its roots system which makes suitable environment for aquatic life. After experimentation the Dissolved oxygen value increased significantly. Similarly % Oxygen saturation values were also found in increasing trend. Aquatic plants transport atmospheric oxygen from foliage in to root (Moorhead and Reddy, 1988, Debusk, 1989,) Oxygen not required for root respiration diffuses in to water system. Chemical oxygen demand (mg/L), an indicator of inorganic pollution in wastewater due to increment of dissolved oxygen in water reduced after the culture, as it provides suitable environment for easily degradation of organic matter in wastewater.

Total hardness, Calcium hardness as mg CaCo3/L was found in range 215.34 – 353.08, 122.76 – 223.74 respectively. Calcium values always found more then Magnesium and ranged 49.20 – 89.67 and 12.45 – 37.43 Mg/L separately. Which were significantly absorbed by *Eichhornia crassipes* and reduced throughout the tenure of research. Deficiency of nitrogen and phosphorous has less adverse effect than calcium. A lack of calcium prevents plants vegetative reproduction, (Desougi, 1984).

Nitrogen as mg/L was determined as three forms Ammonical – N, Nitrite – N and Nitrate – N. All forms were absorbed significantly by the experimental plant, but Nitrate – N was absorbed as higher than other two forms studied and it was ranged 39.90 – 61.32 mg/L, which are main nutrient responsible for the growth of this aquatic plant and optimal for growth.

Phosphate as mg/L was estimated in four forms viz –Total ortho, Acid hydrolysable, Total and Organic phosphate. Maximum phosphate content found 1.742 mg/L (Total phosphate) before culture of *Eichhornia crassipes.* All forms were found as significant absorption by *Eichhornia crassipes* as shown in student *t* test. Present research plays significant role in wastewater treatment, that experimental plant absorb remarkable amount of organic and inorganic compounds.

Percentage change or reduction in the values of various physicochemical parameters were ranged 01-20 percentage for Temperature, pH, Salinity, E.C., T.D.S., Alkalinity, Chloride, 20 - 40 percentage for Turbidity, Total carbon dioxide, Dissolved oxygen, Total hardness, Calcium hardness, Calcium and Magnesium,40 - 60 percentage for Free carbon dioxide,Chemical oxygen demand, Ammonical – N, Nitrite – N , Nitrate – N, Acid hydrolysable Phosphate, Total phosphate and Organic phosphate, 60 - 80 percentage for Nitrate – N, Total ortho phosphate and more than 80 percentage for Oxygen saturation.

(2). Analysis of Generated Data (“t” Test):
Generated data after of present research were subjected in analysis of significance following student “t” test to ensure that changes are significant or not.

(3). Biomass (NPP) determination:
Cultivation of diverse aquatic plants and their utility for biomass (Net Primary Productivity) generation has been observed by Chadwick and Obeid, 1966, Oki and Uki,1978a, Wolverton and Donald, 1979, Reddy and Tucker,1983, Tsutomu and Seiji, 1988, Ripley et al 2006.

After seven days of experiment fresh biomass of Eichhornia crassipes was increased and variable data were used in Net Primary Productivity determination. Harvested biomass of Eichhornia crassipes can potentially be used for composting soil amendments and anaerobic digestion with methane production and processing for manure to increase the amount of nutrients (Verma et al, 2006). Maximum and minimum value of NPP was reported 2.93 and 1.01 gm. per meter square per day. The average NPP value1.74 was gm per meter square per day.

Table - 1. Summary of initial data and % change due to culture of Eichhornia crassipes in domestic wastewater.

Sl. No.	PARAMETERS	UNIT	Domestic wastewater.			
			RANGE (Before Culture)		% Reduction /Change	
			Min.	Max.	Min.	Max.
1	Temperature	0C	24.8	36.60	3.01	15.65
2	PH	-	6.63	7.56	2.95	10.40
3	Turbidity	NTU	10.3	38.9	20.43	37.04
4	Salinity	0/00	0.374	0.903	1.35	6.33
5	Electrical Conductivity	micro-mhos/cm	588.60	961.60	2.29	7.70
6	Total Dissolved Solids	ppm	319.90	620.30	3.24	10.65
7	Total Alkalinity	mgCaCo3/L	232.5	377.5	6.25	17.20
8	Free Co2	mg/L	28.02	168.16	14.60	52.64
9	Total Co2	mg/L	239.22	436.56	10.02	24.88
10	Chloride	mg/L	74.53	137.75	3.01	4.62
11	Dissolved Oxygen	mg/L	1.4	5.5	55.6	22.61
12	Oxygen Saturation	0/0	21.6	72.5	30.6	200.3
13	Chemical Oxygen Demand	mg/L	57.6	223.2	14.29	50.00
14	Total Hardness	mgCaCo3/L	215.34	353.08	15.22	30.52
15	Calcium Hardness	mgCaCo3/L	122.76	223.74	10.84	31.40
16	Calcium	mg/L	49.20	89.67	10.84	31.39
17	Magnesium	mg/L	12.45	37.43	19.01	34.18
18	Ammonical - N	mg/L	6.53	26.19	13.55	56.07
19	Nitrite - N	mg/L	0.311	0.481	20.79	62.06
20	Nitrate - N	mg/L	39.90	61.32	27.56	46.29

21	Total Ortho Phosphate	mg/L	0.530	0.892	37.22	70.87
22	Acid Hydrolyzable Phosphate	mg/L	0.221	0.520	15.00	59.53
23	Total Phosphate	mg/L	1.200	1.742	26.23	56.10
24	Organic Phosphate	mg/L	0.222	0.795	12.69	59.92

All the parameters value decreased after 7 days of culture of Eichhornia crassipes except D. O. and pH.

TABLE - 2

MONTHLY VARIATION IN NET PRIMARY PRODUCUTIVITY gm.m-2.day-1 OF Eichhornia crassipes (OVEN DRY BIOMASS) AFTER 07 DAYS OF CULTURE IN DOMESTIC WASTEWATER DURING.

(INITIAL BIOMASS OF Eichhornia crassipes USED FOR CULTURE = 100 gm.)

MONTHS	PERIOD	PRODUCTION	N.P.P.
		gm.m-2	gm.m-2.day-1
JAN	15th - 22nd	15.89	2.27
FEB	19th - 26th	20.52	2.93
MAR	17th - 24th	15.08	2.15
APR	12th - 20th	11.73	1.67
MAY	12th - 20th	11.27	1.61
JUN	16th - 23rd	9.47	1.35
JUL	06th - 13th	7.91	1.37
AUG	16th - 23rd	7.10	1.01
SEP	15th - 22nd	12.94	1.84
OCT	19th - 26th	11.27	1.61
NOV	16th - 23rd	10.46	1.49
DEC	14th - 21st	10.86	1.55
MEAN X	-	12.04	1.74
+ SD	-	3.69	0.51

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