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WATER HYACINTH (*Eichhornia Crassipes*) AS A REMEDIATION TOOL FOR DYE-EFFLUENT POLLUTION

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ABSTRACT
The potential of water hyacinth (*Eichhornia crassipes*) to remove pollution load of dye waste were investigated. The experiments were carried with the help of 25%, 50%, 75% and 100 % waste water. There was a significant decrease in the pH, TDS, Conductivity, Hardness, DO, BOD, COD and nitrate nitrogen and ammonium nitrogen. It has been concluded that water hyacinth is an efficient plant for treatment of the effluent discharged from the local dye industries.

KEY WORDS: *Eichhornia crassipes;* dye waste; pollution; treatment.

INTRODUCTION
Many industries such as textile, paper, plastic, leather tanning, uses dyes extensively in different operations (Gercel *et al*., 2008; Karaca *et al*., 2008). These dyestuff industries discharge variety of pollutants in different processes (Rao, 2006; Mall *et al*., 2006). Dyes exhibit considerable structural diversity and thus become difficult to treat them by a single process. It is a fact that due their visibility, dyes are recognized easily even at the levels as less as 1ppm. Toxicity of dyes to fauna and flora is well documented (Karaca *et al.,* 2008). Colour of textile effluents escalates environmental problem mainly because of its non-biodegradable characteristics (Southern, 1995).
Today industries are the backbone of economy in many developed as well as developing countries. In India, it contributes to about 25% of total export earning and providing employment to almost ¼ of the total labor force. But, dye pollutants from various industries are important sources of environmental contaminations. Wastewater generated by the dye production industry and many other industries which use dyes and pigments is characteristically high in both colour and organic content. About 10,000 different commercial dyes and pigments exist, and over 7 x 10^5 tones are produced annually worldwide. It was estimated that about 10 - 15% of these dyes are released in effluents during dyeing processes (Grag *et al.,* 2004). Dyes are the serious polluters of our environment as far as color pollution are concerned. Dyes are synthetic aromatic organic compounds, which are normally used for coloration of various substances. During textile processing, inefficiencies in dyeing result in large amounts of the dyestuff (varying from 2% loss when using basic dyes to a 50% loss when certain reactive dyes used) being directly lost to the wastewater, which, ultimately finds its way into the environment (McMullan et al,, 2001; Correia, *et al*., 2004; Neill *et al*., 1999).
Color is a visible pollutant and the presence of even very minute amount of coloring substance makes it undesirable due to its appearance. The effluents from dye manufacturing and consuming industries are highly colored coupled with high chemical and biochemical oxygen demands (COD and BOD) and suspended solids. Discharge of such effluents imparts color to receiving streams and affects its aesthetic value. The dyes are, generally, stable to light, oxidizing agents and heat, and their presence in wastewaters offers considerable resistance to their biodegradation, and thus upsetting aquatic life (Robinson *et al.,* 2001; Aksu 2005)

Parameters	Range
pH	7.0– 9.0
Biochemical Oxygen Demand (mg/L)	80 – 6,000
Chemical Oxygen Demand (mg/L)	150 – 12,000
Total Suspended Solids (mg/L)	15 – 8,000
Total Dissolved Solids (mg/L)	2,900 -3,100
Chloride (mg/L)	1000 – 1600
Total Kjeldahl Nitrogen (mg/L)	70 – 80
Colour (Pt-Co)	50-2500
Oil and grease (mg/L)	10

The application of aquatic plants to the removal of heavy metals from wastewater has gained increasing interest. Some freshwater macrophytes including *Potamogeton lucens*, *Salvinia hergozi, Eichhornia crassipes, Myriophyllum spicatum*, *Cabomba sp.*, *Cratophyllum demersum* have been investigated for their potential in heavy-metal and colour removal. Their mechanisms of metal and colour removal by biosorption can be classified as extracellular accumulation/precipitation, cell surface sorption/precipitation, and intracellular accumulation. These mechanisms can result from complexation, metal chelation, ion exchange, adsorption and micro precipitation (Rai 2002).
The removal of colour from Dye bearing effluents is one of the major problems due to the difficulty in treating such wastewaters by conventional treatment methods. So present study was undertaken To evaluate the phytoremediation potential of water hyacinth (*Eichhornia crassipes*) plants against dye industry effluent and t o

observe the effects of Dye wastewater on the growth of test plants.

MATERIALS AND METHODS

Preliminary Studies

A review of literature was done about the role of aquatic weeds in wastewater treatment. After that local survey was conducted and one aquatic weed was selected for our study i.e. *Eichhornia crassipes*. *E. crassipes* is a free floating hydrophyte. Braru (1968) reported that *Lemna minor L.*, *Azolla Pinnata (*Kunze) and *Eichhornia crassipes* (Mart.) Solms are major free floating weeds of the area. In the present study, the test plants (*Eichhornia crassipes*) were collected from river Kshipra Ujjain near Mangalnath Temple which is considered as a holy river in India.

Water pollution due to colour from dyestuff industries is a topic of major concern of scientists today. About 1,00,000 dyes exists and more than $7x10^5$ tones effluent is produced each year. For our study, we collect Dye wastewater from Bairogarh Ujjain. In Bairogarh maximum dwellers earn their livelihood on dyeing textiles. For this they get consignments from textile industries.

Experimental set up

The test plants (Weight taken after keeping them on a filter paper to remove excess water) were transferred to plastic troughs having capacity of five liters containing dye wastewater in different concentrations. Before transferring plants into troughs, an initial analysis of main physical, chemical and biological parameters was done. The experimental setup was divided into five sets with three triplicates of each:

Set.1. 25% Dye wastewater + 75% Tap water.
Set.2. 50% Dye wastewater + 50% Tap water.
Set.3. 75% Dye wastewater + 25% Tap water.
Set.4. 100% Dye wastewater.
Set.5. Control (Tap water without Dilution).

After 15 days, the analysis of treated water was taken for different physical, chemical and biological parameters. In addition to analysis, the effect on test plants was also noticed. This experiment was repeated several times and finally data has been interpreted on average basis.

Preservation of Samples

Suggested chemical preservatives and recommended maximum storage times for samples for various analyses are summarized in the following table.

Table 2. Preservation of Samples.

Parameters	Preservation Method	Maximum holding period
BOD	Refrigerate at 4°C	26 h
DO	Analyze immediately or fix on site	6 h
NH_3-N	Analyze as soon as possible, add 2 ml 40%, H_2SO_4 to PH<2, refrigerate	24 h
Nitrate	Analyze as soon as possible	
N-Kjeldahl	Refrigerate, add H_2SO_4 to PH<2	7 days

Physico-chemical and Biological Analysis of dye wastewater has been carried out with the following methodology.

pH: Glass electrode method**; (**Jackson 1967)
Conductivity: Conductivity Meter; (Jackson 1967)
TDS: Filtration, Evaporation (103^0c) method: (S.M. APHA 1992)
D O: Modified Winkler's Method (S.M.APHA 1976)
NH_4^+N, NO_3^-: Steam Distillation Method using MgO and Deverda's Alloy :(Bermner & Keeney 1965)
BOD: Modified Winkler's Method :(S.M. APHA 1976)
COD: Open Reflux Method: (S.M. APHA 1992)

RESULTS AND DISCUSSION

Phytoremediation is a new area of treatment technology that takes advantage of fact that certain species of plants and fungi flourish by accumulating waste materials present in the water. It may be applied wherever the static water or soil environment has become polluted or is suffering ongoing chronic pollution. Phytoremediation refers to the natural ability of certain plants called hyperaccumulators to bioaccumulate, degrade or render harmless contaminants in water, air or soil. Phytotechnologies involving use of plants for pollutant removal gained importance during the last two decades. Contaminants such as metals, pesticides, solvents, crude oil and its derivatives have been mitigated in phytoremediation projects worldwide. It is considered a clean, cost-effective and non- environmentally disruptive technology as opposed to mechanical cleanup methods, such as pumping polluted ground water or soil excavation. A new technology, sewage purification by water hyacinth (*Eichhornia crassipes*) is a possible solution (Alade and Ojoawo, 2009).

The present work utilizes the response of a free floating aquatic weed (*Eichhornia crassipes*) to evaluate the remediation of various dye waste water pollutants in different concentration. In this work waste water means dye waste water. This weed is well known for its reproduction potential (De-Casabianca and Laugier, 1995) and as a plant that can double its population in twelve days. It has an ability to grow in severe polluted waters and thus it can improve the effluent quality from oxidation ponds and as a main component of one integrated advanced system for treatment of municipal, Agricultural and industrial wastewaters.

The results indicate that, the test plant (*Eichhornia crassipes*) reduced all the physic-chemical and biological parameters to a significant level up to 50% diluted dye waste waters as shown (Figures 1-10). However, the dissolved oxygen (DO) showed an increasing trend to a significant level. The total dissolved solid reduction by test plant (*Eichhornia crassipes*) is maximum in 50% dye waste water (Fig.2). There occurred a 37.60% decrease in 50% dye wastewater concentration, while as lowest occurs in 100% dye wastewater. It reduced only 10.32%of Total

Dissolved Solids. As far as Conductivity is concerned, water hyacinth decreased the conductivity of all the concentrations. But, it was maximum in 50% dye wastewater where it decreased from 23.5µ mhos to 16.84µ mhos (Fig 3).

Hardness is defined as the concentration of multivalent metallic cations (Ca^{2+}, Mg^{2+}, Sr^{2+}, Fe^{2+}) in solution. The hardness of water varies from place to place. From table 4.4 it shows that water hyacinth is unable to lower hardness in all concentration too much. While it shows maximum reduction in 25% dye wastewater. It showed performance efficiency of 15.35% in 25% dye wastewater.

The level of DO in any water shows condition of pollution level.

In our study, water hyacinth increased the DO level in all dye wastewater samples except in 100% dye waste water (Fig. 5). It showed an increase from 0 to 100% in 75% dye wastewaters around 1.26 mg/l. In 25% and 50% it increases DO also considerably.

The BOD removal by water hyacinth in different concentrations shows that it cannot perform well in 100% dye wastewater having high BOD value. In our study (fig. 6) we found that, it reduced maximum BOD level in 25% dye wastewater and almost same in 50% dye wastewater. *Eichhornia crassipes* reduces about 41.63% BOD from 25% dye waste water. It indicates dilution in dye wastewater induces the performance of the test plant i.e. *Eichhornia crassipes.*

From Fig. 7, the test plant (*Eichhornia crassipes)* shows maximum reduction of COD in 25% dye wastewater, while minimum in 100% wastewater. In 25% dye waste water it reduces COD from 412.9 mg/l to171.2 mg/l.

Nitrogen present in wastewater may be in many forms NO_3N, NH_3N, NO_2N and Organic Nitrogen. Plants grown in wastewater containing nitrogen in many forms as pollutants may be utilized by plants in many ways. Rogers's *et al*, (1991) who concluded plant uptake as the dominant removal mechanism for N. Nitrification-Denitrification complex has been established as the major removal mechanism for nitrogen.

In the present study, the test plants (*Eichhornia crassipes*) removed Nitrogen maximum in 25% dye waste water and minimum in 100% dye waste water as shown in fig.- 8.

As far as Nitrate Nitrogen is concerned, water hyacinth reduced maximum in 25% dye wastewater and minimum in 100% dye wastewater as shown in fig 10. While as Ammonical Nitrogen removal is shown maximum by 50% dye waste water and minimum by 25% dye waste water. This may be due to high pH.

In all parameters it has been found *Eichhornia crassipes* performs well in 25% dye waste water. This indicates dilution enhances the performance of test plants in dye waste water. In 100% dye waste water plant was unable to acclimate well. Because dye waste water contains many toxic compounds in high concentration that may have affected test plants grown in it.

As for as growth is concerned, it has been found in control sets test plants (*Eichhornia crassipes) grows* well in tap water. In control sets plants had bulbous petiole and glossy lamina and roots were well developed. In dye waste water growth varies from low concentrated set to high concentrated set. We see the most of the root loss was found in 100% dye waste water and then in decreasing in order in 75%, 50% and 25% dye waste water. *Eichhornia crassipes* roots in 25% dye waste water and 50% dye waste water were thin and wiry. In 75% and 100% root loss was maximum. In control set (tap water). They were relatively thick, exhibiting spreading tendency. Toxic effect of dye in concentration between 25% & 50% was less severe as compared 100% dye waste water. In 100% *Eichhornia crassipes* was almost dead at the termination of the study.

In the present study it has been found that *Eichhornia crassipes* shows maximum performance in 25% dye waste water. This may be due dilution by tap water. It may have diluted the composition of dye waste and for plant uptake become easy than in highly concentrated dye waste waters.

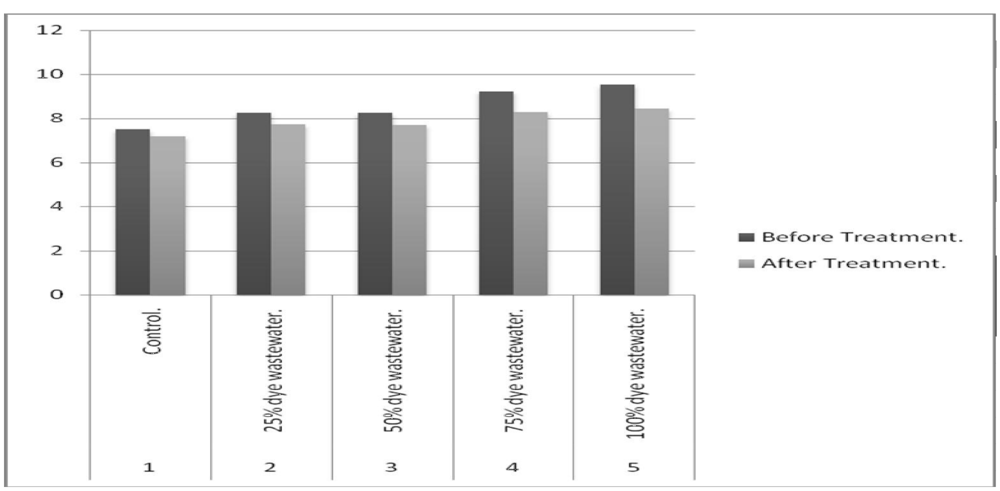

Fig. 1 The values of pH before and after treatment

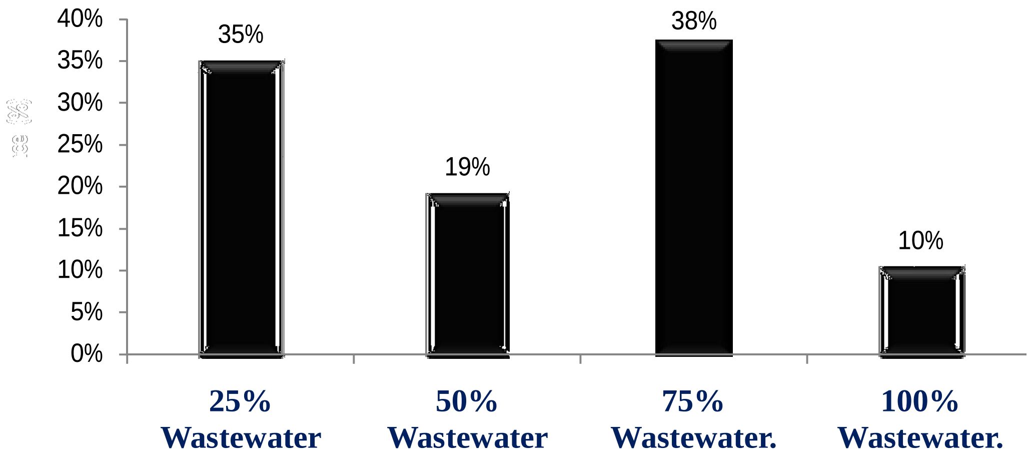

Fig. 2 Treatment Performance in TDS by Water Hyacinth

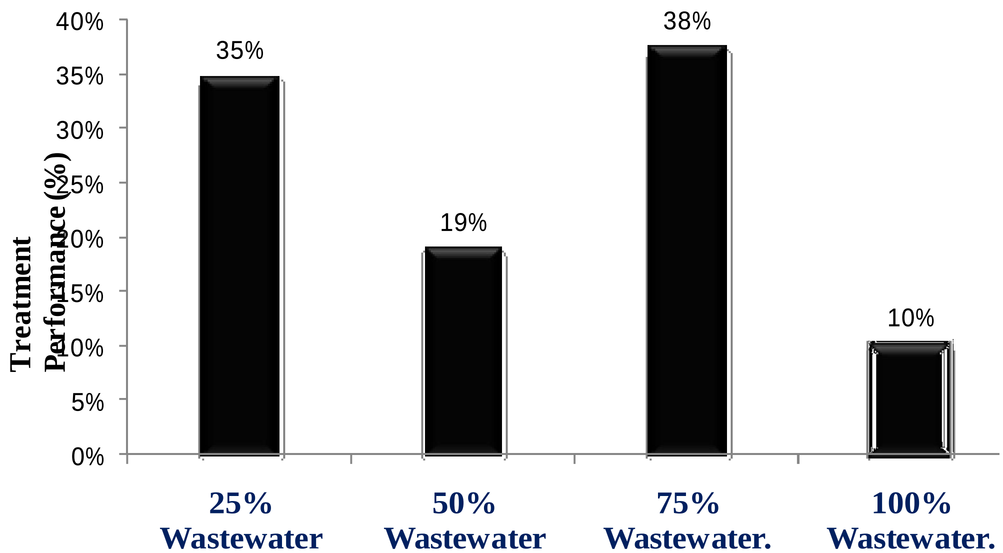

Fig. 3 Reduction Potential (%) of Water Hyacinth in Conductivity

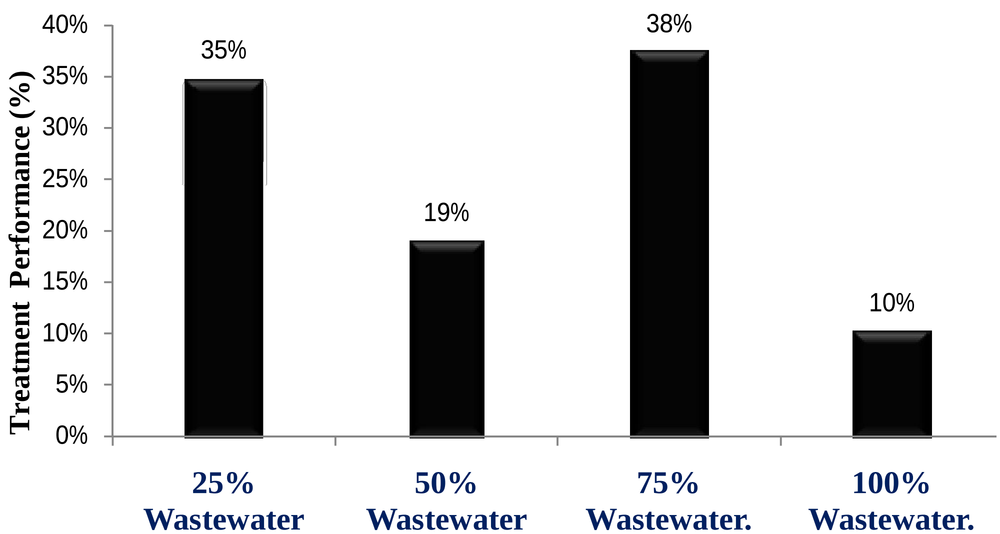

Fig. 4 Removal of Hardness by the test plant (E. *crassipes*)

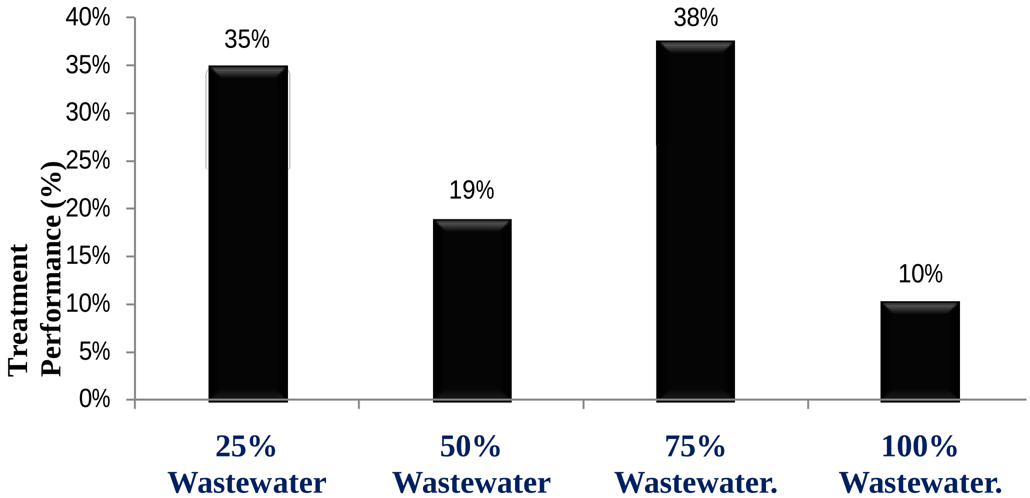

Fig. 5 Increasing level of DO by Water hyacinth in different concentrations

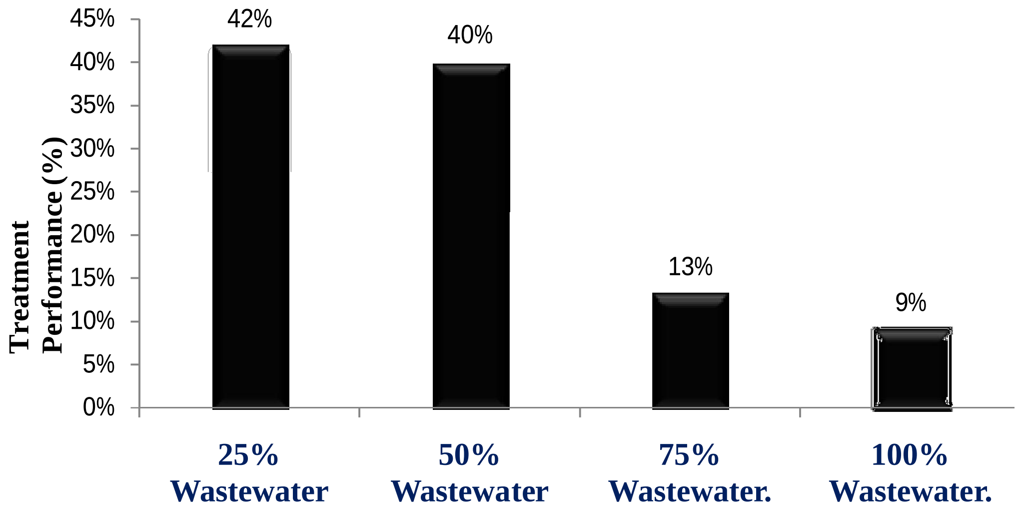

Fig. 6 BOD removal efficiency(%) of Water Hyacinth

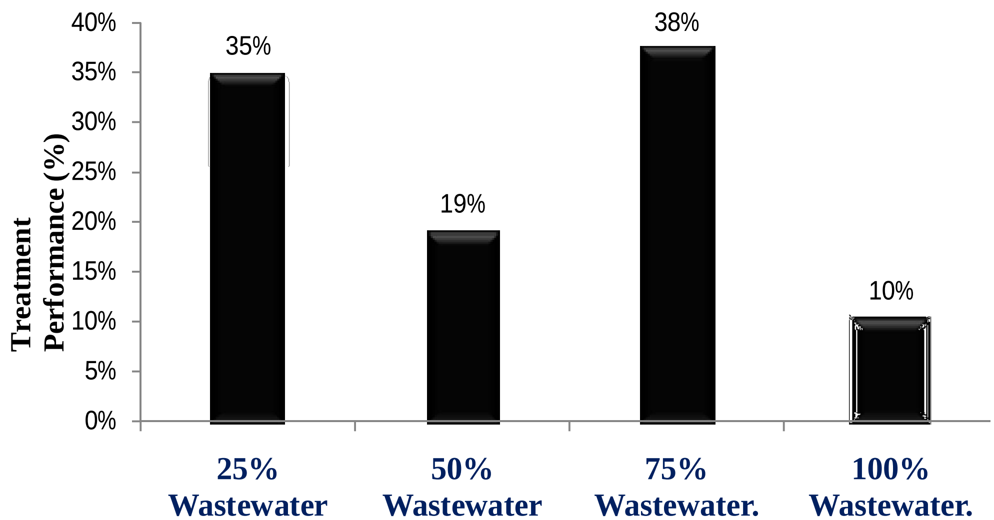

Fig. 7 COD removal efficiency (%) of Water Hyacinth

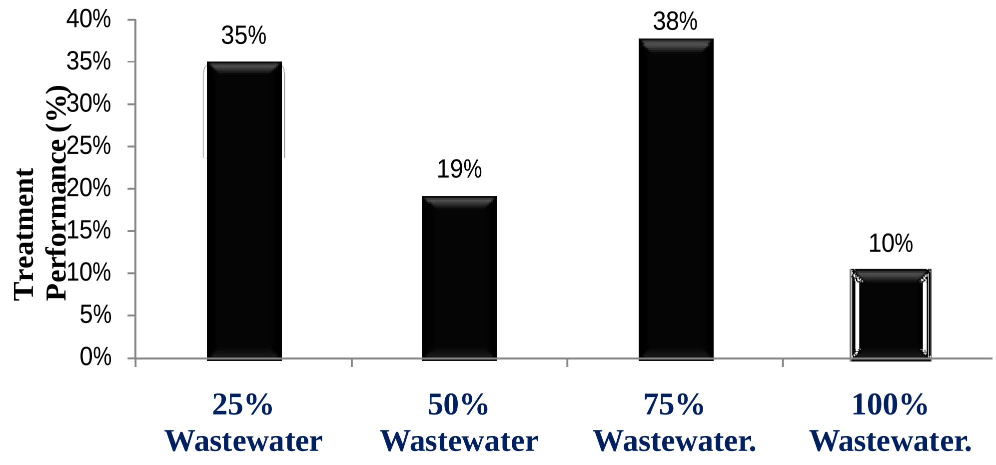

Fig. 8 Treatment Potential (%) of Water Hyacinth in Total Nitrogen

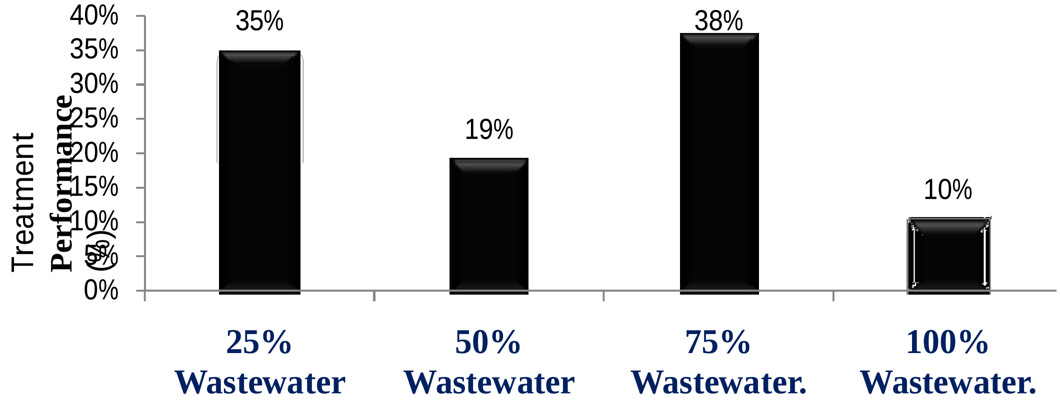

Fig. 9 Removal Efficiency (%) of Ammonium Nitrogen by Water Hyacinth

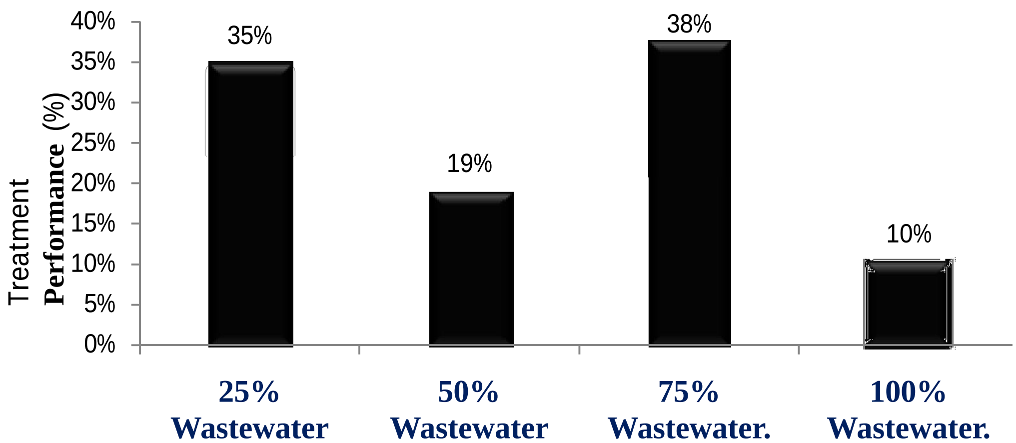

Fig. 10 Removal Efficiency (%) of Nitrate Nitrogen by Water Hyacinth.

CONCLUSION

In this present work, a preliminary study was made to find the potential of *Eichhornia crassipes* in treating dye waste water. It has been found that, water hyacinth performs well in 25%-50% waste water. In 75%-100% dye waste water plants was unable to survive even for few days. It indicates dilution increases potential of *Eichhornia crassipes* to remove pollutants from dye waste water. At higher concentrations, it was observed that dye waste water has toxic effect on the test plants. Keeping in view the result of present study concludes that the water hyacinth can be utilized for treating dye waste water after dilution. An urgent need still exists for exploration of other potential aquatic macrophytes for removal of dye stuffs from waste water with high treatment efficiency.

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