PHYTO REMEDIATION OF WASTE WATER THROUGH AQUATIC PLANTS FOR THE CHANGE DETECTION ANALYSIS IN THE CHEMICAL PROPERTIES WITHIN THE DISTRICT DHANBAD, JHARKHAND

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Abstract

The paper briefly describes the importance of algae, vetiver grass, hydrilla and water hyacinth (Aquatic plant) in the phytoremediation of coal mine and municipal wastewater bio-purifications. A laboratory scale experiment was conducted by taking two mines, one municipal wastewater and which was compared with tap water treated by algae, vetiver grass, hydrilla and water hyacinth. The water samples were collected from mines from Jharia, Dhanbad. Municipal waste water was taken from Bekar Bandh, Dhanbad and were compared with the tap water from C.I.M.F.R, Barwa Road, Dhanbad of Jharkhand. Utilization of aquatic plant for bio-treatment of wastewater was a common practice all over the world. Use of Algae, Vetiver grass, Hydrilla and Waterhyacinth for the treatment of different types of wastewater were being practiced by researchers. But treating mine water by these aquatic plants were not in common. With the view mine water, municipal waste water and tap water were compared by the different combination of algae, vetiver grass, hydrilla and water hyacinth for the reduction or increases in the chemical properties studied e.g., pH, Sulphate, nitrate, and iron content of the water.

Experiment proved that the significant reduction in pH, Nitrate, Sulphate, Iron with Algae, Vetiver grass, Hydrilla and Water hyacinth in all the water samples taken for this study. This type of experiment will have more scope by conducting it at the bigger scale to get accurate results.

Keywords: *Phytoremediation 1, Mine Water 2, Municipal Waste Water 3, Algae 4, Vetiver grass(Vetiveria zizanioides) 5, Hydrilla (Hydrilla verticilita) 6, Water hyacinth [Eichhornia crassipes (Marri, Solms)] 7, and,Tap Water 8, Treatments9.*

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1. INTRODUCTION

Wastewater treatment is the process of taking wastewater and making it suitable for discharging back into the environment. It is an important initiative which has to be taken more seriously for the betterment of the society and our future. The wastewater treatment methods are of three types i.e. physical, chemical and biological.

Physical treatment is very common method where sedimentation, coarse screening, aeration and filtration is done to remove the physically from wastewater. The most common method to treat water using chemicals is chlorination, ozonation and neutralization. The best example is the use of carbon, which adsorbs contaminants to clean the water. Similarly, in biological treatment process, micro-organisms such as bacteria are used to biochemically decompose the wastewater and stabilize the end product. This method is further divided into aerobic and anaerobic system. Use of aquatic floating plant to treat wastewater is also categorized in this method (Araki, et.al., 2003; Archibald, 1972; Awuah, et.al., 2004; Wolverton & McDonald, 1981; Borges, et.al., 2008; Braarud, T, 1945; Butcher, R.W, 1949; Chao, et.al., 2000; Mkandawire and Dudel, 2010; Mulbry, et.al.,2008; Piyush, et.al., 2012; Saravanan, et.al., 2013;Sarijeva, et.al., 2007; Ting, et.al.,1989; Tredici, 2010; Tseng, 2000).

It takes up large amounts of inorganic nutrients (especially Nitrate, Sulphate, Phosphate, etc., (Reddy, 1983)) and heavy metals (such as Cd, Cu, Hg, Fe, Zn, etc.,) as a consequence of the growth requirements (Nakajima, et.al., 1981; Prasad, Prasad, 1995' Sakaguchi. et.al., 1981; Skinner, et.al., 2007; Soeder, 1981; Tukendorf, 1993; Vesk, et.al., 1999; Vesk, et.al., 1999) and decrease the concentration and ultimately lowering down the pH, EC, etc., (Cornwell, et.al., 1977; Craggs, et.al., 1996; Dr.Konstantian bloch, 2001; Dhir, et.al., 2008; Droste, R.L, 1997; Filip, et.al., 1979; Fritioff and Greger 2006; Alade & Ojoawo, 2009; Ghanshyam and Nikhil, 2014; Girija, et.al., 2011; Mazen and Maghraby, 1998) .

This paper investigated the effectiveness of the four floating aquatic plants such as Eichhornia crassipes (Marri, Solms) (Gopal, B, 1987; Reddy and Tucker, 1983; Mahmood, et.al., 2005; Paiva, et.al., 2009and Wooten & Dodd, 1976), Vetiveria zizanioides (Ralph and Paul,2004; Roongtanakiat, 2004), Hydrilla verticilita (Kanabkaew, and Puetpaiboon, 2004; Pal,et.al., 2005; Pal, et.al., 2004; Vasquez, 2008) and Algal spp. e.g Spirogyra, Diatom, Volvox, Oscillatoria, Cynobacterium, Clausterium and Euglen all together in a combination treated all four type of water performed the experiment in the laboratory (Grobbelaar, 1990; Hammouda, et.al., 1994; Hassette, et.al., 1981; Mata, et.al., 2010; Palmer, 1969) i.e. two mine and one municipal wastewater treatment compared with one tap water. The role of these plants in removing nutrients e.g., Nitrogen as nitrate, Sulphur as sulphate, heavy metals like Fe and water pH was noticed in the four different set of aquatic floating plant system treated the four different water sample in this experiment (Kumar Nikhil, 2004; Kumar and Chopra, 2012; Laliberte, et.al., 1994; Lovaie, et.al., 1985; Mackenthum, 1962; Oswald and Gootas, 1957and Oswald, 1988).

2. EXPERIMENTAL LAYOUT

The experiment was conducted and planned for two coal mine and one municipal wastewater with one tap water treated with algae, vetiver grass, hydrilla and water hyacinth and by growing these floating aquatic plants in the tub at laboratory scale experiment in CSIR-CIMFR, Dhanbad, Jharkhand. The experiment was conducts to study the reduction in some of the chemical properties of mine and municipal wastewater compared with one tap water, with an interval of 0 day, 5day, 10 days, 15 days. Purification of coal mine and municipal waste water with tap water were studied and measured the most significant chemical parameters which were highly reduced by these aquatic plants in all sample collected. For achieving the same objective, this experiment was designed.

2.1 Site Details

This study was planned within Jharia Coalfield Area as this is very old coalfield of our country which is highly polluted in the world ranking. Huge opencast coalmining exist in this coalfield and huge amount of waste/mine water is locked within these coal opencast pits within the mining areas unused. With the utilities benefits of this huge waste/mine water for many fold purposes this study was planned which is very smallest approach but for setting a milestone for others experiment was at bigger scale this was carried out.

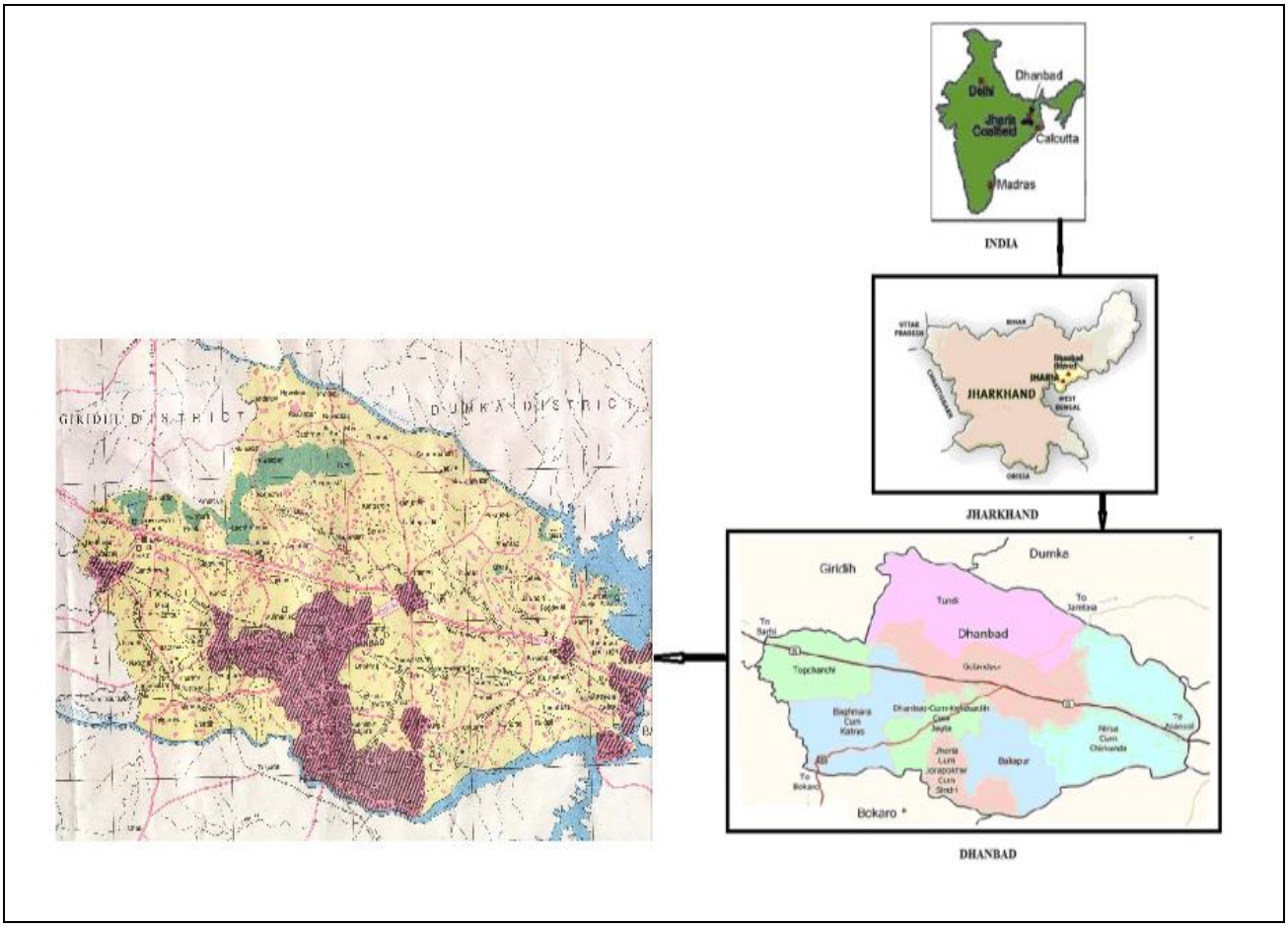

Fig.2.1: Detail site Map

2.2 Sampling Area

Golden pahadi and 36 no. mining area in Jharia Coalfield (JCF) mine area water samples were taken. Along with BekarBandh municipal wastewater and CIMFR tap water were taken for this experiment. These all are situated in district of Dhanbad.

2.3 Geogrophical Location of Experimental Site

Golden pahadi and 36 no. mining area in JCF two mine waste water sample were collected at the geographical coordinates 23.72°N86.40°E and 23.751568°N 86.420345°E respectively. Whereas Bekarbandh pond is situated in longitudes E $86^0$25'45.12"and latitudes N $23^0$48′2.16' and CSIR-CIMFR ,Barwa Road, Dhanbad is situated in between longitudes E $86^0$25'46.1496"and latitudes N $23^0$48′6382' respectively (**Fig.2.1**).

2.4 Material and Lab Instrument

1. All required glassware
2. All required chemical and reagent
3. Electronic Balance
4. pH meter (pH meter)
5. Filter paper
6. Conductivity meter (EC-meter)
7. Nitrate, Sulphate & Iron test (Spectrophotometer)
8. Water measuring beaker
9. Required Tub of 10 liters water capacity
10. Algae
11. Water hyacinth
12. Vetiver grass
13. Hydrilla

2.5 Methodology

Local algal species in combination were identified by the help of microscope and water hyacinth (Eichhorniacrassipes) is a perennial, freshwater aquatic vascular plant with rounded, upright, shiny green leaves and spikes of lavender flowers were live plants brought for conducting the experiment. The petioles of the plant are spongy with many air spaces and contribute to the buoyancyof the hyacinth plant. When grown in wastewater, individual plants range from 0.5 to1.2 m (20 to 47 in.) from the top of the flower to the root tips. The plants spreadlaterally until the water surface is covered and then the vertical growth increases. Waterhyacinths are very productive photosynthetic plants.

Algal, Vetiver grass, Hydrilla and Water hyacinth samples are collected for the study and purification of coal mine and municipal waste water. These algal, Vetiver grass, Hydrilla and Water hyacinth floating aquatic plants samples are collected from Bekarbandh pond in district of Dhanbad.

To study the biopurification of coal mine and municipal wastewater, the following experiment design employed were shown in the Table**. 2.1**.

(i) MW1= Golden pahadi Mine Water, Bwhora
(ii) MW2= Jharia Mine no.36 Mine Water
(iii) BBW= BekarBandh pond Water
(iv) TW= Tap Water

One hundred sixty (160) small tubs were brought with a capacity of 10 liters water. All tubs were arranged in sixteen rows (treatments) with the ten replications in each treatment. In the first set, first-four row tubs (treatment) were filled with 10 lit of Golden pahadi mine waste water (1) treated with algae, water hyacinth, vetiver grass and hydrilla. Whereas in the second set 36 no. mining area in Jharia Coalfield from fifth-eighth rows contain mine waste water (2) treated with these four aquatic plants. Further, in the ninth to twelfth rows the municipal waste water from Bekarbandh were treated with these four aquatic plants. Again from thirteen row to sixteen rows the tap water which were treated with these four aquatic plants (**Table.2.1**) and chemical parameters were recorded by taking water sampling done after 0, 5,10 and 15 days of growth of these four aquatic weeds in the tub (**Table2.2**).

Table 2.1: Layout design of the experiment

	TAPE WATER	**BEKAR BANDH**	**MINE WATER 1**	**MINE WATER 2**
WATER HYACINTH	TWWH	BBWH	MW1WH	MW2WH
VETIVER GRASS	TWVG	BBVG	MW1VG	MW2VG
HYDRILLA	TWH	BBH	MW1H	MW2H
ALGAE	TWA	BBA	MW1A	MW2A

Table.2.2: Layout of time for recording data

0 day	**D1**
After 5 days	D2
After 10 days	D3
After 15 days	D4

All the chemical parameters were studied through standard methodology recommended by ISO9001:2009.

3. FINDINGS & DISCUSSION

3.1 pH

In the four different type of water taken as MW1, MW2, BB and TW treated with water hyacinth found increases in pH by 3.5, 2.8, 2.8 and 0.7% increment in between 0-5 days and 0, 2.8, 4.2 and 5.7% increment in between 5-10 days and finally found 2.8, 2.1, 4.2 and 0% increment in between 10-15 days intervals.

Whereas, when it is treated with vetiver grass it found increases in pH by -2.1, 2.8, 2.1 and 3.5% increment in between 0-5 days and 0.7, 0, 0 and 3.5% increment in between 5-10 days and 4.2, 2.1, 3.5 and 2.8% increment in between 10-15 days intervals.

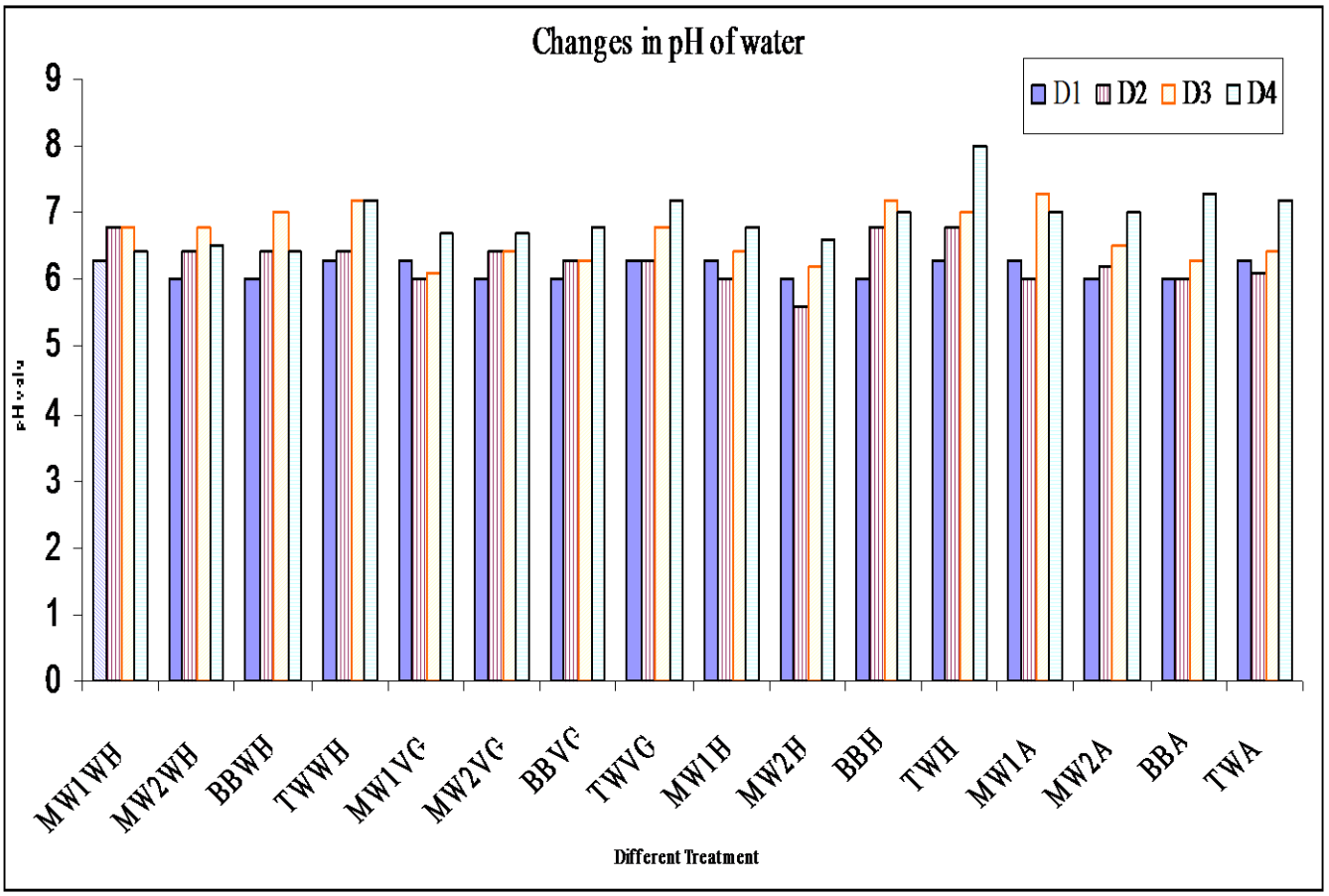

Fig.3.1: pH of the water samples

Wherein, treated with hydrilla found increases in pH by -2.1, -2.8, 5.7 and 3.5% increment in between 0-5 days and 2.8, 4.2, 2.8 and 1.4% increment in between 5-10 days and 2.8, 2.8, 1.4 and -7.1% increment in between 10-15 days interval.

Further, treated with algae found increases in pH by -2.1, 1.4, 0 and -1.4% increment in between 0-5 days and 9.2, 2.1, 2.1 and 2.1% increment in between 5-10 days and 2.1, 3.5, 7.1 and 5.7% increment in between 10-15 days interval. Mine wastewater is always acidic in nature increment is positive point and reduction results further acidic in nature. (-) increment means reduction in values.

Kumar et. al, (2014) reported maximum of 4% reduction in pH in mine wastewater treated with algae after 5 days duration. Manoharan and Subramaniyam (1993) agreed with above finding. But in the experiment within 10^{th} days to 15^{th} days of water treatment through algae and water hyacinth increases the pH instead of reduction. Wolvertonet. al, (1979), reported a decreases in pH in textile mill effluents with water hyacinth treatment. Moreover, Gamage and Yapa, (2001), reported the same reduction in pH.

3.2 NIitrate

In the four different type of water taken as MW1, MW2, BB and TW treated with algae found reduction in nitrate by 0, 77.77, 77.77 and 0% in between 0-5 days and 44.44, -48.89, -22.22 and 100% in between 5-10 days with -66, -28, -55 and 0% change in between 10-15 days interval.

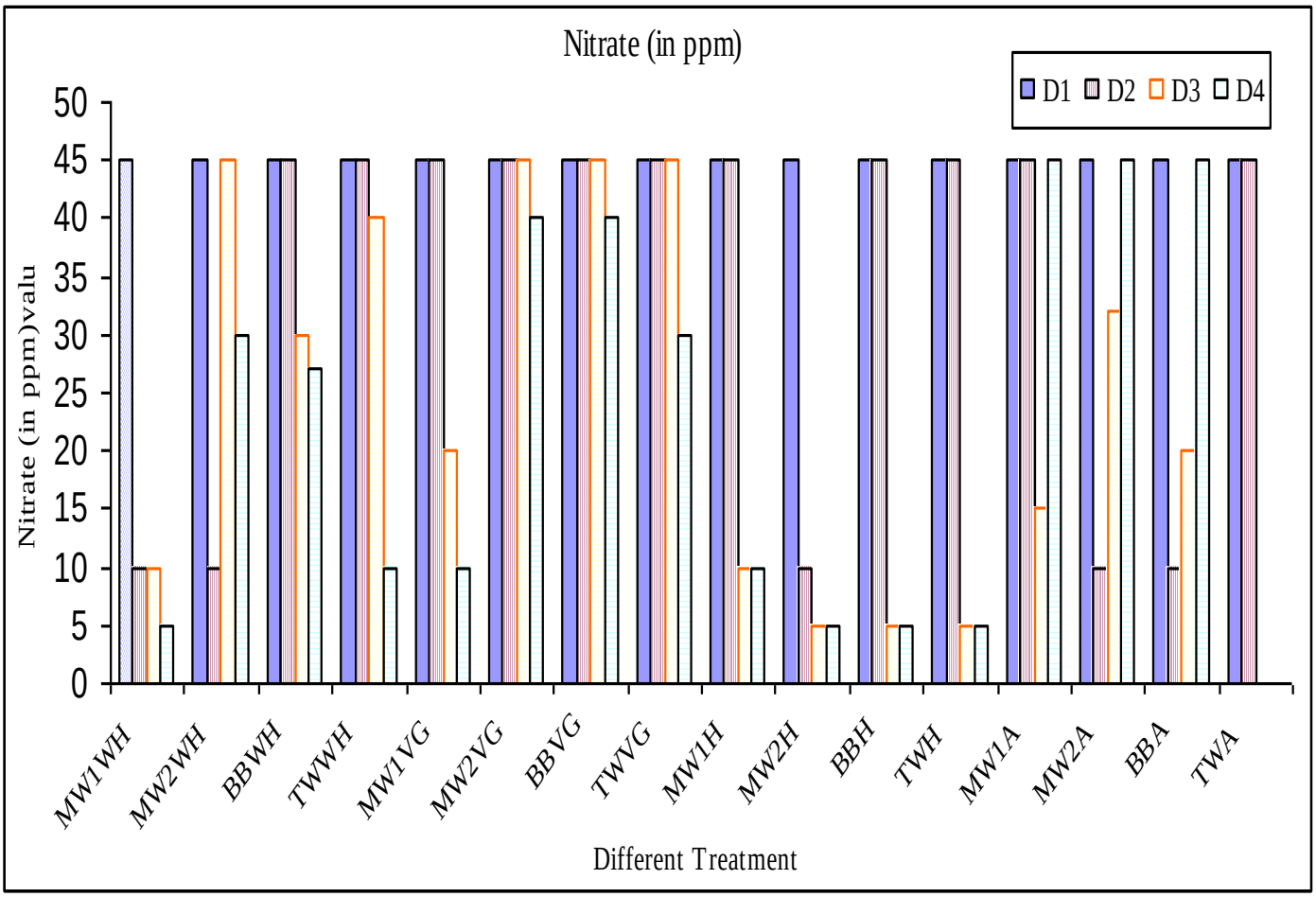

Fig.3.2: Nitrate in the water samples

In the four different type of water taken as MW1, MW2, BB and TW treated with hydrilla found reduction in nitrate by 0, 77.77, 0 and 0% in between 0-5 days and 77, 11, 88 and 88% in between 5-10 days and 77, 88, 88 and 88.89% in between 10-15 days interval.

In the four different type of water taken as MW1, MW2, BB and TW treated with vetiver grass found reduction in nitrate by 0, 0, 0 and 0% in between 0-5 days and 11.11, 11.11, 33.33 and 0% change in between 5-10 days and 77, 11, 11 and 33.33% reduction respectively within 10-15 days interval.

In the four different type of water taken as MW1, MW2, BB and TW treated with water hyacinth found reduction in nitrate by 77, 77, 0 and 0% in between 0-5 days and 0, -77, 33 and 11% within 5-10 days and finally 88, 33, 51 and 77% in nitrate concentration within 10-15 days of interval.

These result corroborat with finding of Kshirsagar, (2013), and Rao et. al., (2011), who reported 78% and 70% reduction in nitrate nitrogen using algae in wastewater treatment. Tartte, et. al., (2010), observed effective removal of nitrogenous contaminant of waste water using Anabena and Nostoc algal species. Similarly recorded by the finding of Sengar et. al., (2011) who supporting the above trend and noted 91% reduction in nitrate using mixed algal population. The uptake and utilization of nitrate by algae species for their growth may be the reason for reduction in nitrate (Fig. 5.4 to 5.6). Whereas, Wooten and Dodd (1976) reported 100% removal of nitrate in water hyacinth system. Whereas, Sinclair and Forbes, 1980 reported 52.6% and Cornwell, et. al., (1977) reported 8.4% of removal of Nitrate from wastewater containing water hyacinth.

3.3 Iron

In the four different type of water taken as MW1, MW2, BB and TW treated with water hyacinth found reduction in iron by 20, 40, 40 and 40% within 0-5 days and 20, 20, 40 and 40% reduction in between 5-10 days with a final reduction of iron 40, 20, 40 and 40% in between 10-15 days interval.

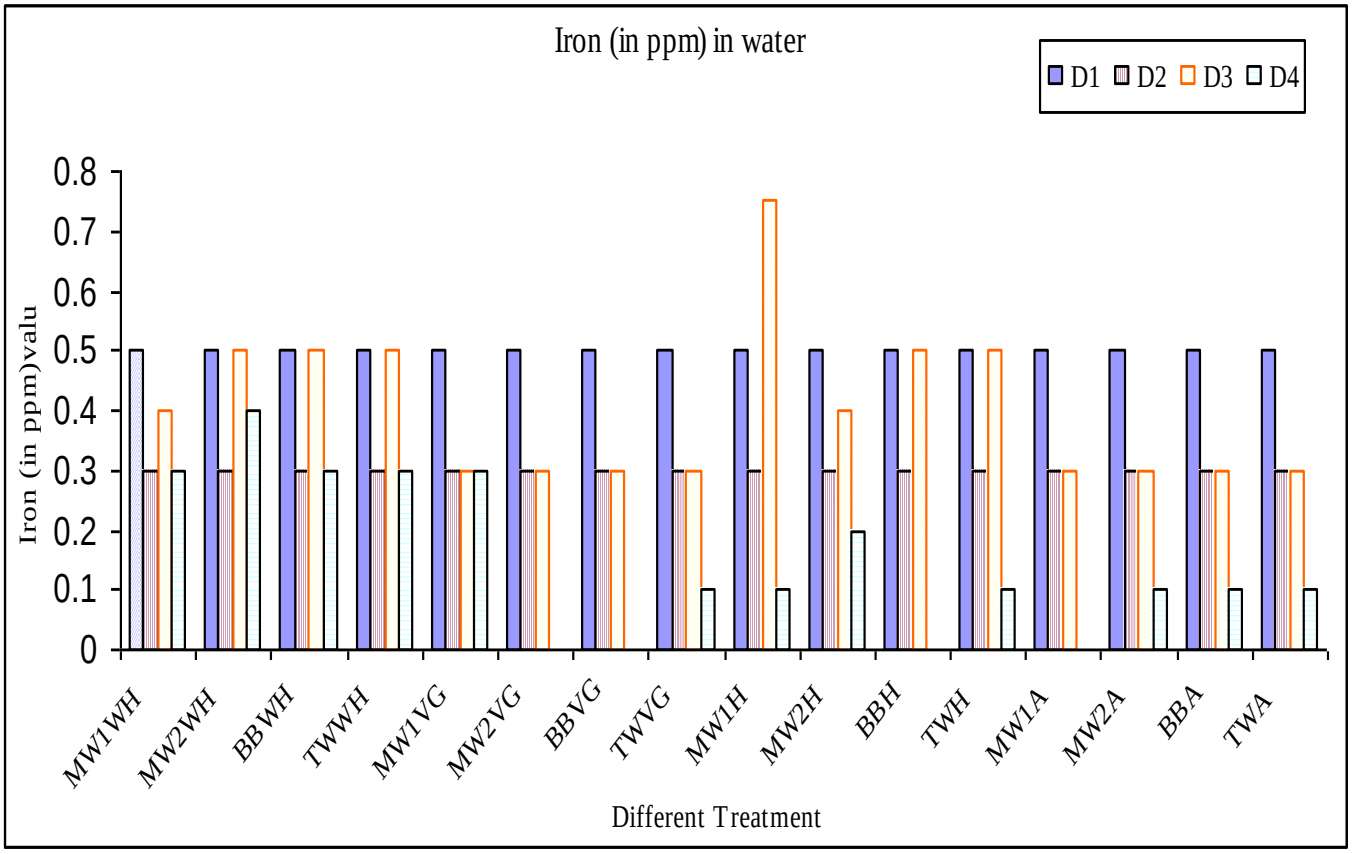

Fig.3.3: Iron in the water samples

In the four different type of water taken as MW1, MW2, BB and TW treated with vetiver grass found reduction in iron by 40% in all sample in between 0-5 days and 0, 60, 60 and 40% reduction in between 5-10 days and finally reduction in concentration of iron by 40, 100, 100 and 80% in between 10-15 days.

In the four different type of water taken as MW1, MW2, BB and TW treated with hydrilla found reduction in iron by 90, 20, 40 and 40% in between 0-5 days and 130, 40, 100 and 80% reduction in between 5-10 days and finally change in concentration of iron by 80, 60, 100 and 80% in the interval of 10-15 days.

In the four different type of water taken as MW1, MW2, BB and TW treated with algae found reduction in iron by 40% in all sample in between 0-5 days and further 60, 40, 40 and 40% reduction within 5-10 days and finally concentration of iron by 100, 80, 80 and 80% after 10-15 days interval.

Water hyacinth have high removal rate for Fe reported by Piyush Gupta et. al.,(2012). Mishra et. al., (2008), used water hyacinth for coal mining effluents for the removal of heavy metal and observed 70.5 ± 4.4 Fe was removed. Kumar et al (2014) reported reduction of 99% Fe in 5 mine water treated with algae after 5 days. The drastic change metals concentration in wastewater firstly observed by Oswald and Gootas, (1957).

3.4 Sulphate

In the four different type of water taken as MW1, MW2, BB and TW treated with water hyacinth found reduction in sulphate concentration by 25, 27.5, 24.3 and 25% within 0-5 days and by 25, 25, 24.39 and 25% in between 5-10 days with final reduction by 50, 62, 63 and 50% sulphate within 10-15 days interval respectively.

In the four different type of water taken as MW1, MW2, BB and TW treated with vetiver grass found reduction in sulphate concentration by 25, 25, 33 and 25% in between 0-5 days and 25, 37, 22 and 37% reduction in between 5-10 days and finally was 50, 62, 66 and 62.50% reduction in sulphate in between 10-15 days interval.

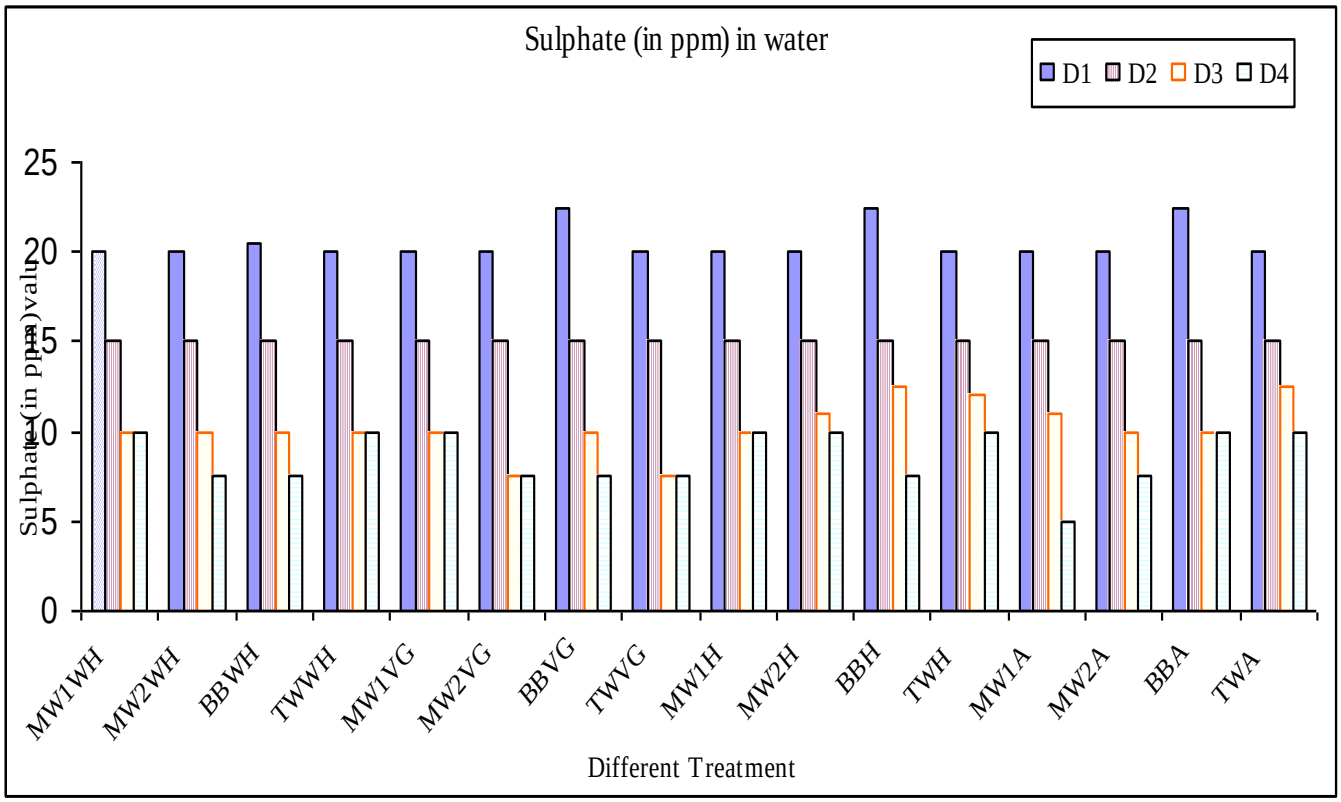

Fig.3.4: Sulphate in the water samples

In the four different type of water taken as MW1, MW2, BB and TW treated with hydrilla found reduction in sulphate concentration by 25, 25, 33 and 25% and 25, 20, 11 and 15% reduction in between 5-10 days with finally sulphate reduction by 50, 50, 66 and 50% in between 10-15 days intervals.

In the four different type of water taken as MW1, MW2, BB and TW treated with algae found reduction in sulphate concentration by 25, 25, 33 and 25% within 0-5 days and by 20, 25, 22 and 12.5% reduction in between 5-10 days finally 75, 62, 55 and 50% reduction in between 10-15 days interval.

These results are in agreement with studies of Chandra et al., (2004) who reported more than 99 % reduction in SO4-2 of tannery effluent with Nostoc.

Same trend was recorded by Ahmad et al., (2013) who also reported considerable reduction in SO4-2 using Chlorella and mixed algal culture. Elumalai et al., (2013) reported removal of very high amount of SO4-2 using consortium of algae as compare to single culture of Chlorella and Scynedesmus. Kumar and Chopra, (2012) recorded very high reduction in SO4-2 in municipal wastewater by using microbiological technology. In present study the SO4-2 removal capacity of both the algae was at par indicating equal efficiency for eliminating of SO4-2 from wastewater which may be contributed to its high uptake from polluted water for growth of algal species.

4. CONCLUSION

Bio-remediation of nitrate, sulphate, iron and lowering pH through four aquatic floating plants treated with two mine, one municipal waste and tap water in district Dhanbad shown result by significant reduction in the above nutrients in concentration with due course of time. Further, this technique can be substantially checked with its economic value as a whole process. This technique is sustainable approach in the area of zero waste management.

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