WASTEWATER TREATMENT BY PHYCOREMEDIATION AND OVERALL REMOVAL EFFICENCY ANALYSIS OF HEAVY METALS PARAMETERS AT THREE DISCHARGE EFFLUENT SOURCE IN GOMTI RIVER LUCKNOW , UTTAR PRADESH

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ABSTRACT

This present Study was undertaken to analyze the efficiency of fresh water green algae scenedesmus specie. Sewage wastewater has enrichment of many nutrients so it can be used for green algae growth for the treatment of wastewater effluent discharge the strain was cultured in wastewater for 14 days in different flasks. The heavy metal parameter of wastewater were analyzed before and after algal treatment. Scenedesmus sp. was able to enhance the pH in wastewater. After treatment with the algal strain , there was a significant removal of heavy metals and analyzed by AAS respectively. Phycoremediation is the method of using water algae for the removal of biotransformation of toxic from wastewater. In this study effluent discharge wastewater from three location in Gomti river was taken at three different month as to check the overall percentage treatment removal efficiency by analyzing all the data gathered from three month and single site concentration and treatment removal efficiency analysis is done and result shows subsequent removal. The micro algae strain is cultured in wastewater taken from three different site in Gomti river for 18 day in three different flasks and optical density absorbance of Scenedesmus species was noted at every two days after inoculation of algae in wastewater on spectrophotometer at 680nm. The highest algae growth optical density was measured at fourteen day this signifies that all values after algae treatment is taken at fourteen day. So,the Heavy metal analysis is carried out initial day i.e. before algae treatment and final value is taken on fourteen day after algae treatment. Heavy metal analysis final reading taken on fourteen day of algae growth in waste water. The present study show the reduction of wastewater by scenedesmus sp. of all three site at three different month the overall removal performance efficiency showed significant results reduction of heavy metal also showed the three month overall removal performance efficiency was increased and the scenedesmus sp. give results effectively. The result of this study suggest that Scenedesmus sp. can be used as effective removal and heavy metals by Phycoremediation technique and this technique is cost effective, ecofriendly as compare to other technique.

Keywords: Phycoremediation, Optical density, HS, KND, GHCD.

1. INTRODUCTION

Wastewater contamination caused due to various anthropogenesis activities was a very severe environmental problem and disposal of municipal waste water was one of the major issue. Wastewater originates from various activities like combination of domestic, industrial, commercial, or agricultural treated and untreated activities. Untreated wastewater contain micro pollutants, organic, inorganic, and other toxic compounds. Disposal of polluted and untreated wastewater into water bodies cause serious and various environmental problems. Overabundance quantity of untreated wastewater causes disorder in environmental habitat. According to the reports of Central Pollution Control Board (CPCB), New Delhi, India creation of waste water is roughly 40 billion liters for each day and only 20-30% of the wastewater is treated and disposed by various techniques. India is a developing country and various pollutants like surfactants, phenol, and heavy metals (Zn, Cd, Cr, Fe, Mn, Pb, Cu, Ar etc.) are not efficiently treat by the customary treatment methods So there is a need to create new and advance economical natural methods for waste water treatment. Wastewater pollution is the contamination of water bodies due to various anthropogenic activities. Water bodies includes rivers, lakes, pond, aquifer, oceans and groundwater. Wastewater pollution in River is defined as the introduction of contaminants into the natural river source that posses risk to the environment and living organisms.

The sewage water is well off in generous metals and diverse dangerous parts. As a result of bringing down of water table and absence of water framework sources in making countries, they use sewage water which is prudent decision. Phycoremediation procedure helps in the treatment of sewage wastewater harmful foreign substances from wastewater. In this procedure miniature green growth is utilized to deteriorate the poisonous toxins into less harmful structure. Algal based wastewater treatment structures (phycoremediation) offer a doable response for the treatment of homegrown and mechanical wastewater astounding procedure to wipe out metals from homegrown and modern release. In this cycle green growth ingest the poisons present in wastewater through the green growth cell surface called physical adsorption.

In this study we selected the scenedesmus sp. for the treatment sewage wastewater at three different site for three different month and the main aim of the present study is to determine overall removal performance efficiency of heavy metals present in sewage wastewater after algae treatment.

2. MATERIALS AND METHODS

2.1. Study site sample collection and Examination

Wastewater samples is collected from effluent discharge source from public sewer at Gomti River, Lucknow total three collection site was taken first at Hanuman Setu Drain (HS) [Latitude 26.860355N, Longitude80.938693E], second at Kukrail Nala (KND) [Latitude 26.867711N, Longitude 80.967302E], and third point was GH canal Nala drain (GHCD) [Latitude 26.83499N, Longitude 80.970794E].

All the waste water samples were gathered in 1 Liter containers at three different months December, January, February. Tests were put away at 4^{o}c until further investigation of exploration work is performed in laboratory. Wastewater quality heavy metals parameters taken in this research study such Pb, Ar, Cu, Mn, Cr, Fe, Cd, were analyzed before and after phycoremediation to determine the pollutants present in the wastewater. Therefore phycoremediation removal efficiency of heavy metals was calculated according to equation 1 all the taste were performed according to the BIS standard method for the examination of water and wastewater .

Removal Efficiency (%) $= \frac{A' - C'}{A'} x100\%$ (Eq. 1)

Where A'= Initial reading before algae treatment

C'= Final reading after algae treatment

2.2. Microalgae strain culture and inoculation

A previously reported microalgae strain Scenedesmus sp. growth was monitored in terms of absorbance and heavy metals characterization of wastewater culture was performed after 0 and 14 days of incubation. After 14 days of inoculation, heavy metals pollutants and analyzed for all the batch cultures. The glass wares were autoclaved at 180℃ for 3 hours In this research work wastewater is used as media and Scenedesmus species were used in waste water for the growth , survived in the pH range of 6-10 and at a temperature range of 10-50^{o} C, algae and was used as the efficient removal for the waste water parameters . During this experiment we used liquid media, fresh water algae. 5ml algal suspension is used as inoculum for 150ml media of 300 ml Erlenmeyer flask in BOD incubator at 28- 32^{o} C. 3 conical flask were prepared each month in this research work.

2.3. Determination of algal growth

Growth of algal samples was monitored at every 2 days interval up to 14 days by measuring optical density absorbance (O.D.) at 680 nm using a UV visible spectrophotometer. After14 days of algae growth all the physico-chemical parameter are tested and the overall performance evaluation was calculated according to three month analysis at all three location.

Table 2.1. Optical density absorbance reading on spectrophotometer at 680nm

Days	HS (O.D.)	KND (O.D.)	GHCD (O.D.)
2	0.6432	0.7511	0.6974
4	0.9648	0.9827	0.9974
6	1.1221	1.2521	1.2102
8	1.1723	1.4513	1.3814
10	1.2143	1.6318	1.4621
12	1.3376	1.7621	1.6182
14	1.8236	1.9726	1.8764
16	1.1022	1.1728	1.1064
18	1.0433	1.0548	1.0974

Table 2.1. shows the optical density absorbance at each site the maximum value showing at 14 day after algal growth which signifies that algae growth in waste water is higher optimization and after wards the density absorbance is decreases so it is concluded that the final reading after algae treatment is taken on 14 day at each three site.

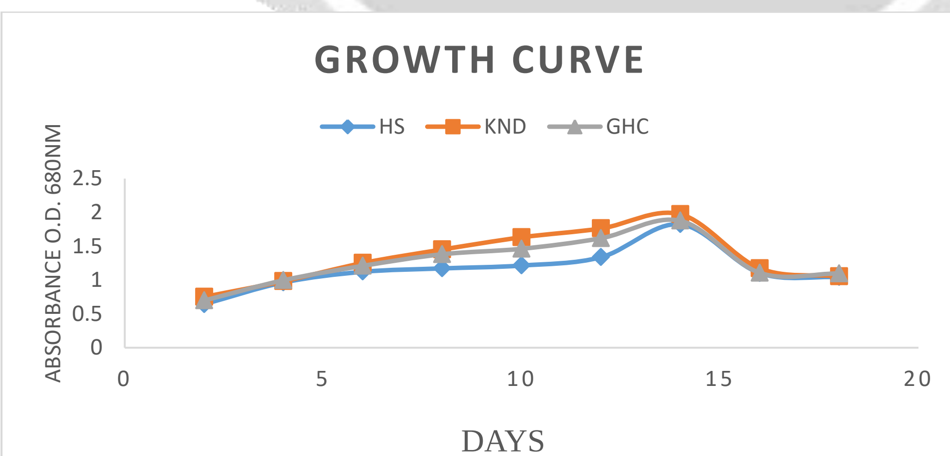

Fig 2.1. Growth curve by optical density at 680 nm

Fig 2.1. shows the media in which the inoculation is done are placed in a BOD incubator at 28-32℃ so that the algae can grow. As we are working on green photosynthetic algae hence proper amount of light is also required for its growth and for scenedesmus sp the light intensity was 3500 to 4000 Lux . After every 2 day up to 18 day the algal density was checked by a spectrophotometer at wavelength 680nm to analyze the growth. The optical density absorbance in each three sample was observed in increasing pattern upto to 14 day and at 14 day it show maximum optical density of growth period it indicates that micro algae was adopting the waste water by consuming waste water nutrients present in each sample efficiently.So by referencing this growth the final reading after algae treatment is taken on fourteen day of each month.

2.4. Analysis of Heavy metals characterization of wastewater before and after algal treatment

Heavy metal characterization of wastewater was carried out with respect heavy metals quality parameters taken in this research study such as heavy metals parameters taken in this research study such Pb, Ar, Cu, Mn, Cr, Fe, Cd, were analyzed before at intial day and after 14 day of observing maximum optical density phycoremediation to determine the pollutants present in the wastewater. The result obtained from algae treatment in waste water from December, January, February was taken at initial temperature of waste water at three sites the temperature was 23.4^{o}C, 25.6^{o}C and 28.3^{o}C and after algae treatment there is no temperature difference.

2.5. **CPCB General standards of effluent discharge**

Table 2.2. CPCB effluent discharge standard

S.NO	PARAMETERS	CPCB EFFLUENT DISCHARGE LIMIT PUBLIC SEWER
1	LEAD	1.0
2	ARSENIC	0.2
3	MANGANESE	2
4	CHROMIUM	2
5	CADMIUM	1
6	COPPPER	3
7	IRON	3

4. RESULT AND DISCUSSION

4.1. Single site concentration trend of all three location and Overall treatment performance efficiency at three different month of heavy metals characteristics

Single site Concentration trend and treatment performance efficiency at three different month of heavy metals characteristics. The concentration and treatment performance efficiency of different heavy metals parameters by phycoremediation was conducted in this section at three different site, HS, KND, GHCD for three different month, December, January, February and inter concentration variation and percent removal with in the site is shown in figure graphically.

At initial day and after 14 day algae treatment has been given in treatment performance efficiency. The samples was analyzed by AAS (Atomic Absorption Spectroscopy) to estimate the removal of selected different heavy metal from waste water. The result of the heavy metals before and after algae strain treatment is given by percentage performance efficiency. Microalgae remove heavy metals from wastewater as they generate mucilaginous substance made up of polysaccharides known as extra cellular polysaccharides that has the capacity of metal binding and algae have large surface area to adsorb much amount of pollutant from wastewater and algae also have peptides which bind with heavy metals and form organometallic complex which enter into vacuoles for controlling the cytoplasmic concentration of heavy metals in this way algae check the toxic effects of heavy metals. The peptide chain are called phytochelatins and metallothioeins and its presence in algae make them capable to survive in high concentration of heavy metals.

4.1.1. Lead

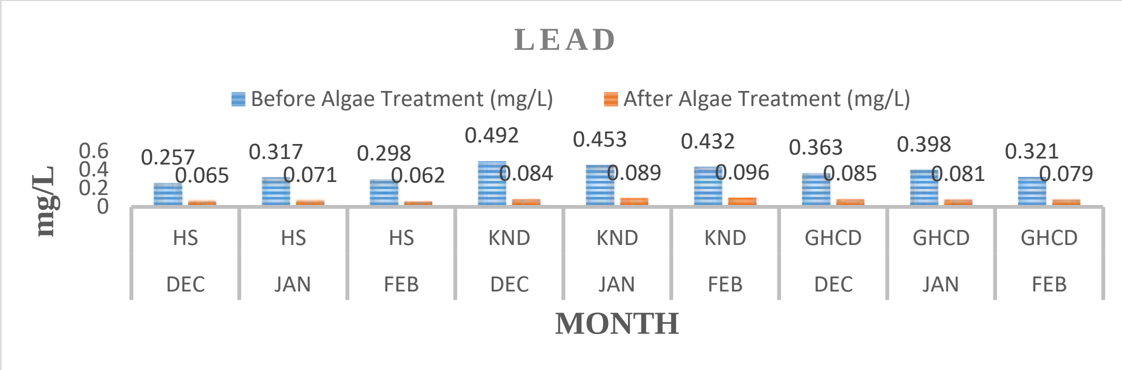

Fig 4.1. Concentration of Lead in waste water at Hanuman setu, Kukrail nala drain, GH canal drain before and after algae treatment at three different month

Fig 4.1. Shows the Lead concentration before and after algae treatment at Hanuman setu initial reading in December was 0.257 mg/ L and final after algae treatment was 0.065 in January initial 0.317 and final 0.071 in February 0.298 and final 0.062. Kukrail nala drain shows Lead concentration before and after algae treatment in December initial reading was 0.492 and final after algae treatment was 0.084 in January initial was 0.453 and final 0.089 in February 0.432 and final 0.096 mg/L.GH canal drain Lead concentration before and after algae treatment in December initial reading was 0.363 and final after algae treatment was 0.085 in January initial was 0.398 and final 0.081 in February 0.321 and final 0.079 mg/L. All data is compared with CPCB discharge standard limit of lead which shown that all data of lead in permissible after algae treatment.

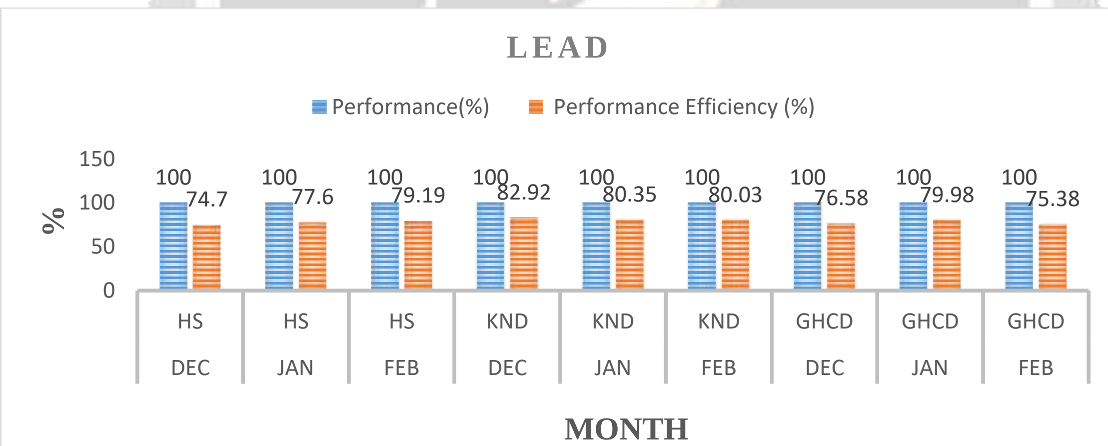

Fig 4.2 Percentage treatment removal efficiency of Lead after algae treatment

Fig 4.2. shows the Performance efficiency of lead after algae treatment in Hanuman setu drain was of three month analysis more than approx. 80%. Kukrail nala drain Performance efficiency of lead after algae treatment was show the analysis of three month at kukrail drain was also not more than approx. 82%. GH canal drain. Performance efficiency of lead after algae treatment the analysis of three month the maximum removal efficiency was also not more than 80%.The removal efficiency indicates lead not more than approx. 85% at all three site, shows that algae is also remove the toxic metal present in wastewater .

4.1.2. Arsenic

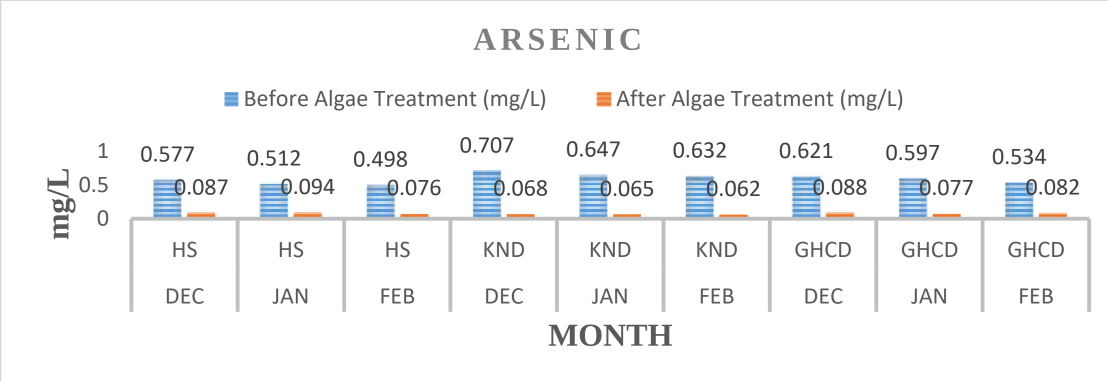

Fig 4.3. Concentration of Arsenic in waste water treatment at Hanuman setu, Kukrail nala drain, GH canal drain before and after algae treatment at three different month

Fig 4.3. Shows the Arsenic concentration before and after algae treatment at Hanuman setu initial reading in December was 0.577 mg/L and final after algae treatment was 0.087 in January initial 0.512 and final 0.094 in February 0.498 and final 0.076. Kukrail nala drain shows Arsenic concentration before and after algae treatment in December initial reading was 0.707 and final after algae treatment was 0.068 in January initial was 0.647 and final 0.065 in February 0.632 and final 0.062 mg/L..GH canal drain Arsenic concentration before and after algae treatment in December initial reading was 0.621 and final after algae treatment was 0.088 in January initial was 0.597 and final 0.077 in February 0.534 and final 0.082 mg/L. All data is compared with CPCB discharge standard limit of arsenic which shown that all data of arsenic in permissible after algae treatment indicates algae is good removal source of arsenic concentration.

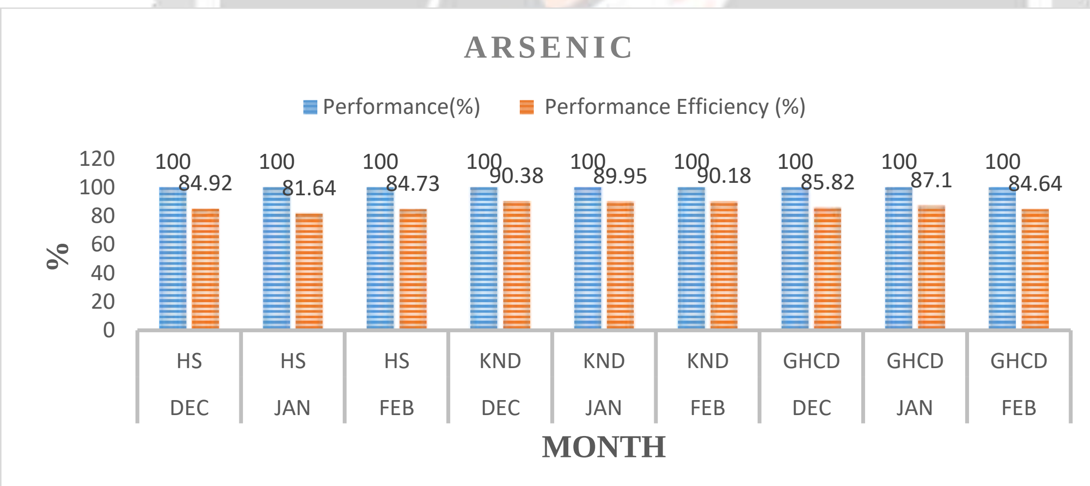

Fig 4.4. Percentage Treatment removal efficiency of Arsenic after algae treatment

Fig 4.4. shows the Performance efficiency of arsenic after algae treatment in Hanuman setu drain was of three month analysis more than approx. 80%. Kukrail nala drain Performance efficiency of arsenic after algae treatment was show the analysis of three month at kukrail drain was also not more than approx. 82%. GH canal drain. Performance efficiency of arsenic after algae treatment the analysis of three month the maximum removal efficiency was also not more than 80%.The removal efficiency indicates arsenic not more than approx. 85% at all three site, shows that algae is also remove the toxic metal present in wastewater.

4.1.3. Copper

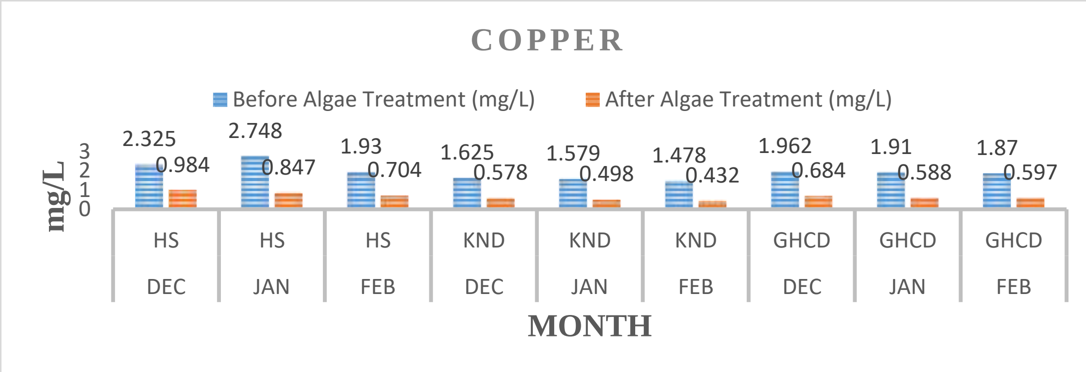

Fig 4.5. Concentration of Copper in waste water at Hanuman setu, Kukrail nala drain, GH canal drain before and after algae treatment at three different month

Fig 4.5. Shows the Copper concentration before and after algae treatment at Hanuman setu initial reading in December was 2.325 mg/L and final after algae treatment was 0.984 in January initial 2.748and final 0.847 in February 1.93 and final 0.704. Kukrail nala drain shows Copper concentration before and after algae treatment in December initial reading was 1.625 and final after algae treatment was 0.578 in January initial was 1.579 and final 0.498 in February 1.478 and final 0.432 mg/L..GH canal drain copper concentration before and after algae treatment in December initial reading was 1.962 and final after algae treatment was 0.684 in January initial was 1.91 and final 0.588 in February 1.87 and final 0.597 mg/L. All data is compared with CPCB discharge standard limit of copper which shown that all data of copper in permissible after algae treatment indicates algae is good removal source of arsenic concentration.

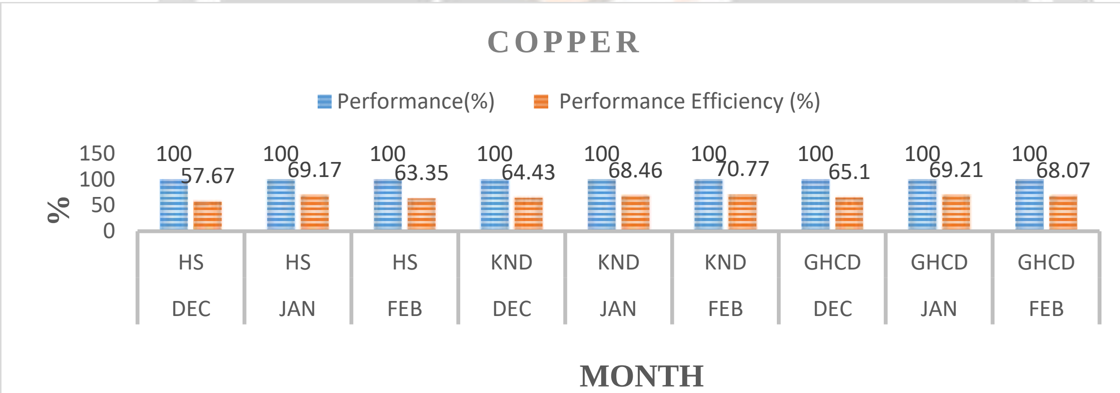

Fig 4.6. Percentage treatment removal efficiency of Copper after algae treatment

Fig4.6. shows the Performance efficiency of copper after algae treatment in Hanuman setu drain was of three month analysis more than approx. 70%. Kukrail nala drain Performance efficiency of copper after algae treatment was show the analysis of three month at kukrail drain was also not more than approx. 70%. GH canal drain. Performance efficiency of copper after algae treatment the analysis of three month the maximum removal efficiency was also not more than 70%.The removal efficiency indicates copper not more than approx. 70% at all three site, shows that algae is also remove the toxic metal present in wastewater.

4.1.4 Manganese

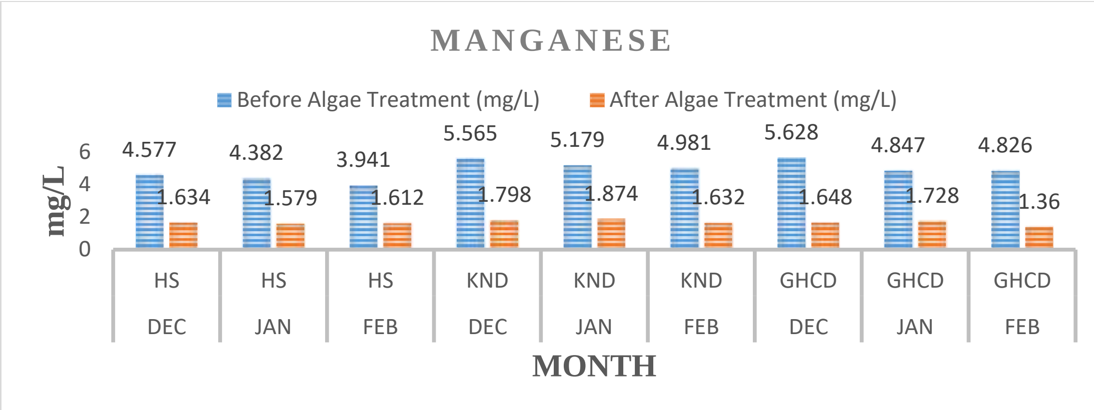

Fig 4.7. Concentration of Manganese in waste water at Hanuman setu, Kukrail nala drain, GH canal drain before and after algae treatmentat three different month

Fig 4.7. Shows the Manganese concentration before and after algae treatment at Hanuman setu initial reading in December was 4.577 mg/L and final after algae treatment was 1.634 in January initial 4.382and final 1.579 in February 3.941 and final 1.612. Kukrail nala drain shows Manganese concentration before and after algae treatment in December initial reading was 5.565 and final after algae treatment was 1.798 in January initial was 4.981 and final 1.632 in February 4.981 and final 1.632 mg/L..GH canal drain Manganese concentration before and after algae treatment in December initial reading was 4.981 and final after algae treatment was 1.632 in January initial was 4.847 and final 1.728 in February initial 4.826 and final 1.36 mg/L. All data is compared with CPCB discharge standard limit of Manganese which shown that all data of lead in permissible after algae treatment indicates algae is good removal source of Manganese concentration.

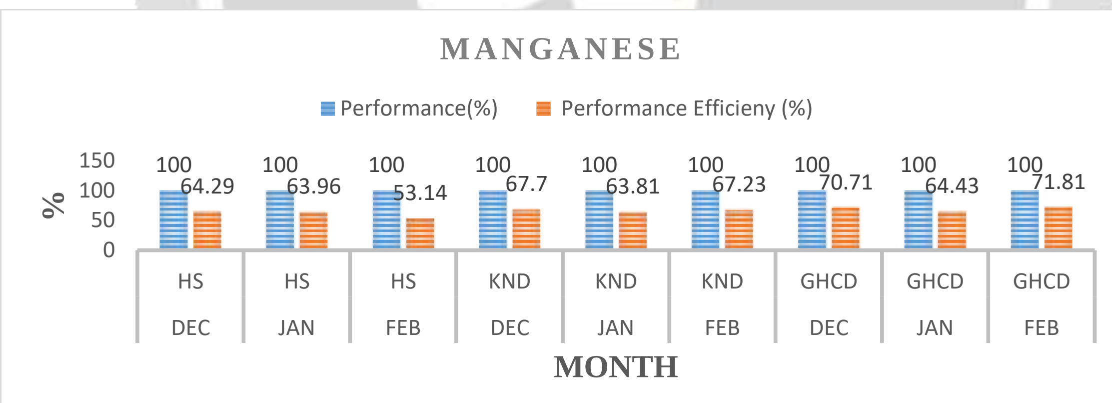

Fig 4.8. Percentage treatment removal efficiency of Manganese after algae treatment

Fig4.8. shows the Performance efficiency of manganese after algae treatment in Hanuman setu drain was of three month analysis more than approx. 70%. Kukrail nala drain Performance efficiency of manganese after algae treatment was show the analysis of three month at kukrail drain was also not more than approx. 70%. GH canal drain. Performance efficiency of manganese after algae treatment the analysis of three month the maximum removal efficiency was also not more than 72%.The removal efficiency indicates manganese not more than approx. 75% at all three site, shows that algae is also good removal of manganese toxic metal present in wastewater.

4.1.5. Chromium

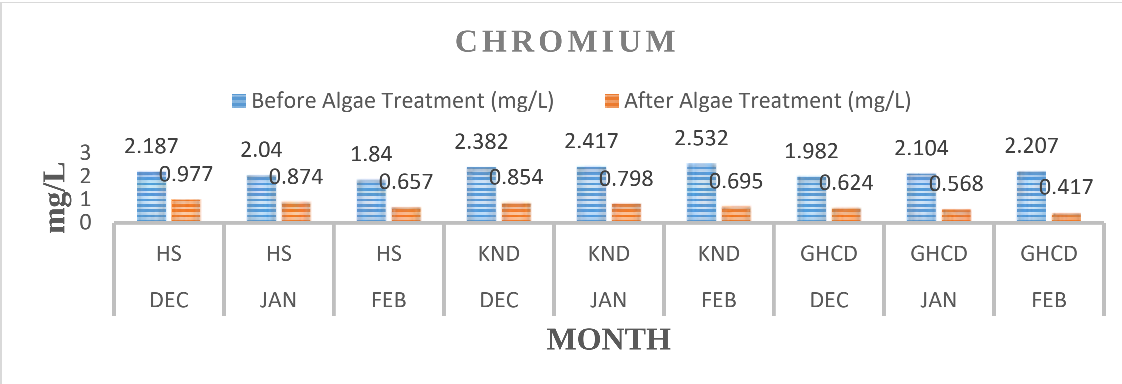

Fig 4.9. Concentration of Chromium in waste water at Hanuman setu, Kukrail nala drain, GH canal drain before and after algae treatment at three different month

Fig 4.9. Shows the Chromium concentration before and after algae treatment at Hanuman setu initial reading in December was 2.187 mg/L and final after algae treatment was 0.977in January initial 2.04and final 0.874 in February 1.84 and final 0.657..Kukrail nala drain shows Chromium concentration before and after algae treatment in December initial reading was 2.382 and final after algae treatment was 0.854 in January initial was 2.417 and final 0.798 in February 2.532 and final 0.695 mg/L..GH canal drain Chromium concentration before and after algae treatment in December initial reading was 1.982 and final after algae treatment was 0.624 in January initial was 2.104 and final 0.568 in February initial 2.207 and final 0.417 mg/L. All data is compared with CPCB discharge standard limit of Chromium which shown that all data of chromium in permissible after algae treatment indicates algae is good removal source of chromium concentration.

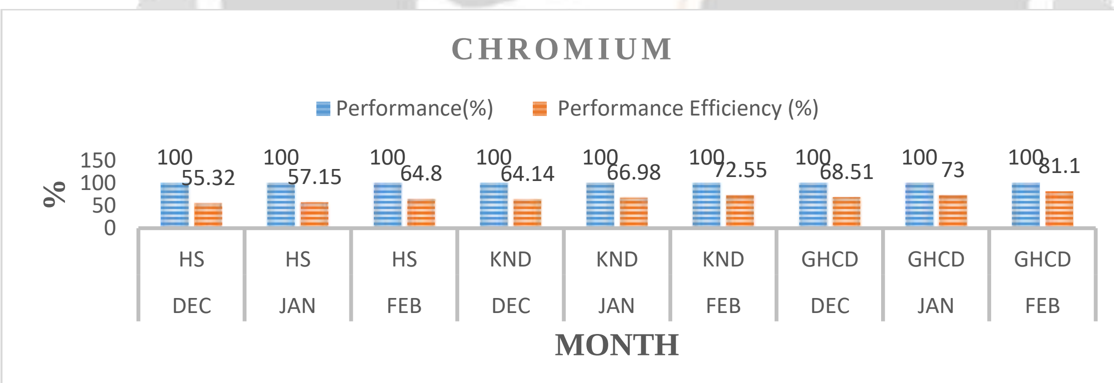

Fig 4.10. Percentage treatment removal efficiency of Chromium after algae treatment

Fig 4.10. shows the Performance efficiency of chromium after algae treatment in Hanuman setu drain was of three month analysis more than approx. 70%. Kukrail nala drain Performance efficiency of chromium after algae treatment was show the analysis of three month at kukrail drain was also not more than approx. 75%. GH canal drain. Performance efficiency of chromium after algae treatment the analysis of three month the maximum removal efficiency was also not more than 82%.This analysis of chromium removal efficiency indicates chromium less than approx. 85% at all three site, shows that algae is also good removal of chromium toxic metal present in wastewater.

4.1.6. Iron

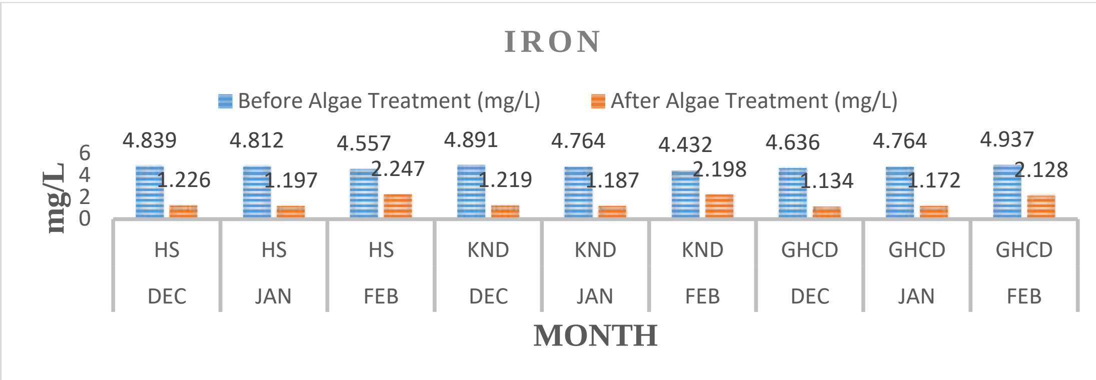

Fig 4.11.Concentration of Iron in waste water at Hanuman setu, Kukrail nala drain, GH canal drain before and after algae treatment at three different month

Fig 4.11. Shows the Iron concentration before and after algae treatment at Hanuman setu initial reading in December was 4.839 mg/L and final after algae treatment was 1.226 in January initial 4.812and final 1.197 in February 4.557 and final 2.247. Kukrail nala drain shows. Iron concentration before and after algae treatment in December initial reading was 4.891 and final after algae treatment was 1.219 in January initial was 4.764and final 1.187 in February 4.432 and final 2.198 mg/L.GH canal drain Iron concentration before and after algae treatment in December initial reading was 4.636 and final after algae treatment was 1.134 in January initial was 4.764 and final 1.172 in February initial 4.937 and final 2.128mg/L. All data is compared with CPCB discharge standard limit of Iron which shown that all data of Iron in permissible after algae treatment indicates algae is good removal source of Iron concentration.

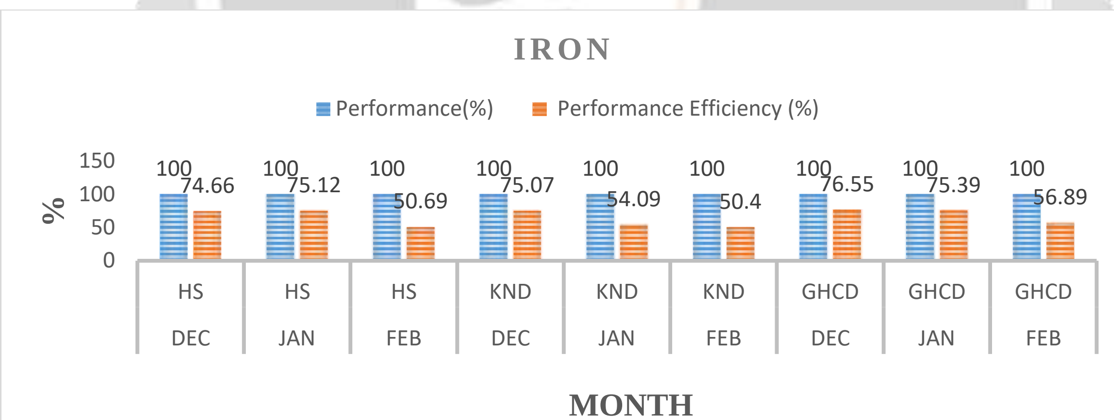

Fig 4.12. Percentage treatment removal efficiency of Iron after algae treatment

Fig 4.12. shows the Performance efficiency of Iron after algae treatment in Hanuman setu drain was of three month analysis less than approx. 75%. Kukrail nala drain. Performance efficiency of Iron after algae treatment was show the analysis of three month at kukrail drain was also not more than approx. 75%. GH canal drain. Performance efficiency of Iron after algae treatment the analysis of three month the maximum removal efficiency was also not more than 76%.This analysis of Iron removal efficiency indicates less than approx. 80% at all three site, shows that algae is also good removal of Iron toxic metal present in wastewater

4.1.7. Cadmium

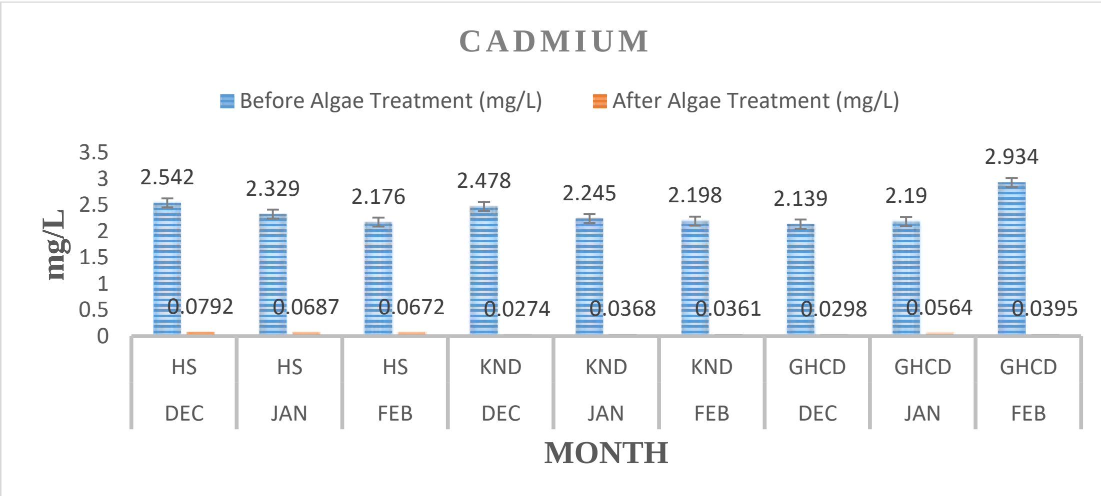

Fig.4.13. Concentration of Cadmium in waste water at Hanuman setu, Kukrail nala drain, GH canal drain before and after algae treatment at three different month

Fig 4.13. Shows the cadmium concentration before and after algae treatment at Hanuman setu initial reading in December was 2.542 mg/L and final after algae treatment was 0.0792 in January initial 2.329and final 0.0687 in February 2.176 and final 0.0672. Kukrail nala drain shows Iron concentration before and after algae treatment in December initial reading was 2.478 and final after algae treatment was 0.0274 in January initial was 2.245and final 0.0368 in February 2.139 and final 0.0361 mg/L.. GH canal drain Cd concentration before and after algae treatment in December initial reading was 2.139 and final after algae treatment was 0.0298 in January initial was 2.19 and final 0.0564 in February initial 2.934 and final 0.0395 mg/L.

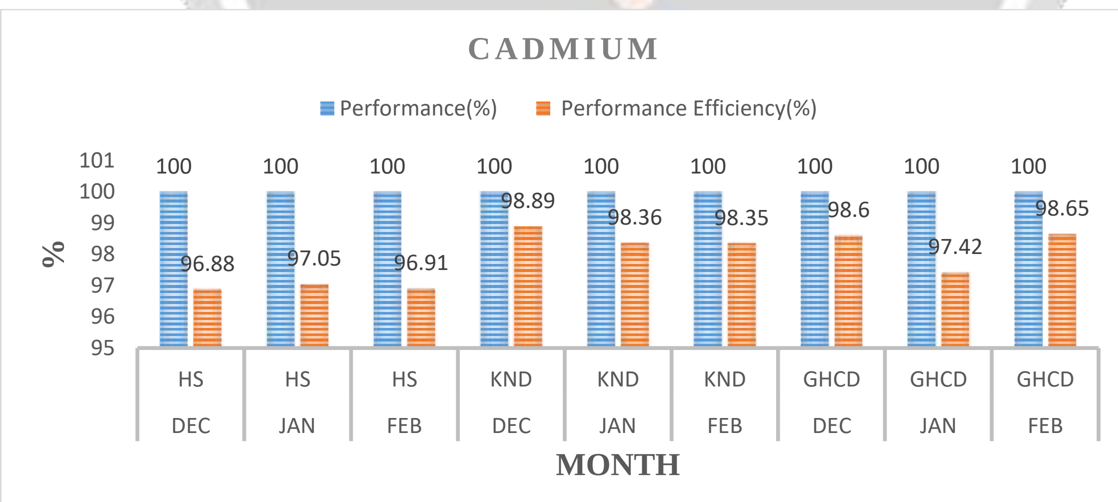

Fig 4.14.Percentage treatment removal efficiency of Cadmium after algae treatment

Fig 4.14. shows the Performance efficiency of Cadmium after algae treatment in Hanuman setu drain was of three month analysis approx. 98%. Kukrail nala drain Performance efficiency of Cadmium after algae treatment was show the analysis of three month at kukrail drain was more than 98% . GH canal drain. Performance efficiency of Cadmium after algae treatment the analysis of three month the maximum removal efficiency was also more than

98%.This analysis of Cadmium removal efficiency indicates more than approx. 98% at all three site, shows that algae is also good removal of Cadmium toxic metal present in wastewater.

4.2. Removal efficiencies of phycoremediation

The removal efficiency of scenedesmus sp. in phycoremediation of sewer wastewater has been summarized in Section 4.1 and all the heavymetals parameters are discussed according to final result came from the phycoremediation. The results after 14 day treatment the overall removal efficiency of all three location at three different month is Pb concentration increased. Lead removal increased efficiency up to (85%), Arsenic up to (85%), Copper up to (70%), Manganese up to (75%), Chromium up to (85%), Iron up to (80%), Cadmium up to (98%). The heavy metals concentration also compared with CPCB effluent discharge limit even though the heavy metal found in permissible limit, but after treatment with algae it found under permissible limit.

5. CONCLUSION

The result obtained from this study from waste water showed that the utilization of green growth algae in water, phycoremediation is extremely successful removal potential for physcio-chemical and heavy metals in waste water and industrial waste water . Phycoremediation is the most effective removal strategy as it is a practical, simple to deal with, less work is required. Produce no auxiliary side-effects and deposits can be utilized for biofuel creation.

This investigation found that phycoremediation procedure is exceptionally simple technique to diminish and reuse of waste water contamination. The current examination uncovers the forthcoming utilization of the fresh water green algae, Scenedesmussp.for the treatment of wastewater had the option to use supplement effectively. There was likewise a noteworthy decrease in level of substantial heavy metals and natural contaminants after treatment. So there is a major need to investigate this ecofriendly strategy to reuse water assets and decrease of water contamination in India.

The present study show the reduction of wastewater by scenedesmus sp. of all three site at three different month the overall removal performance efficiency showed significant results reduction of heavy metal also showed the three month overall removal performance efficiency was increased and the scenedesmus sp. give results Lead removal increased efficiency up to (85%), Arsenic up to (85%), Copper up to (70%), Manganese up to (75%), Chromium up to (85%), Iron up to (80%), Cadmium up to (98%). The result of this study suggest that Scenedesmus sp. can be used as effective removal and heavy metals by phycoremediation technique and this technique is cost effective, ecofriendly as compare to other technique.

The use of sewage effluent discharge wastewater to grow green algae is particularly interesting from point of sustainability. This study proved that Scenedesmus sp. microalgae is used for the phycoremediation treatment of wastewater as it is capable of reducing certain common pollutants found in sewage wastewater. This investigation found that phycoremediation procedure is exceptionally simple technique to diminish and reuse of waste water contamination. The current examination uncovers the forthcoming utilization of the fresh water green algae, Scenedesmus sp. for the treatment of effluent sewer wastewater had the option to use supplement effectively.

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