INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

Assessment of Heavy Metal Removal Efficiency of *lemnaminor*

Ekta Chaudhary
Research Scholar, Department of Environmental Sciences and Engineering
GJUS&T, Hisar, Haryana, India
Dr. Praveen Sharma
Professor, Department of Environmental Sciences and Engineering
GJUS&T, Hisar, Haryana, India

Abstract:
Waste water treatments through 'conventional methods', which rely on heavy aeration, are expensive to install and operate as well as waste generated from such technologies possessed a great hazards to the ecosystem. Phytoremediation is a novel technology for wastewater treatment as well as heavy metal removal.Most of the heavy metals are toxic or carcinogenic in nature and may pose a threat to human health and the environment at higher concentrations. This review paper illustrating the efficiency of lemna minor (common Duckweed) for heavy metal removal. Any aquatic plant that is capable of recovering or extracting nutrients or pollutants and has a fast growth rate coupled with high nutritive value is an excellent candidate for bio-remediation of waste waters. Lemnaminor appear to be the better alternative and have been recommended for wastewater treatment as they are more tolerant to cold than water hyacinth as well as more easily harvested than algae, and capable of rapid growth. The aim of the paper is oriented towards eco-friendly, low cost wastewater treatment with the use of Lemnaminor plant for the benefit of the society.

Keywords*: Lemnaminor, Phytoremediation, wastewater Treatment, Heavy metal*

1. Introduction

Heavy metal pollution in aquatic ecosystem poses a serious threat to aquatic biodiversity, and drinking contaminated water poses severe health hazards in humans.In phytoremediation, plants are used to remediate the environment from various hazardous pollutants like heavy metals. It is cost-effective and ecofriendly technology for wastewater treatment.Industries such as steel industries, smelters, metal refineries and electroplating,mining operations have been documented as major sources of metal release into the environment (Gardea-Torresdey et al., 1997; Srivastava et al., 2007). Most of the heavy metals are toxic or carcinogenic in nature and pose a threat to human health and the environment (Shakibaie et al., 2008; Vinodhini and Narayanan, 2009). Copper (Cu), nickel (Ni), cadmium (Cd) and zinc (Zn) are considered as toxic since they cause deleterious effect in plants, animals and humans. Phytoremediation is based on the use of plants to remove contaminants from the environment (Suthersan, 2002). This technology has proved to be a viable option to purify water contaminated with trace elements since it is cost-effective and has a positive impact on the environment (Raskyn et al., 1997).Duckweed is a small, free–floating aquatic plant belonging to the Lemnaceaefamily (Landolt, 1998). Various duckweed species have been used for the treatment of municipal and industrial wastewaters in many countries, including Bangladesh, Israel, and the U.S. (Alaerts et al., 1996; Culley et al., 1981; Oron, 1994; Oron et al., 1988; van der Steen et al., 1998). Duckweeds (family Lemnaceae) appear to be the better alternative and have been recommended for wastewater treatment as they are (i) more tolerantto cold than water hyacinth, (ii) more easily harvested than algae, and (iii) capable of rapid growth (Shanti S. Sharma , J.P. Gaur.1994). The small size, simple structure and rapid growth make duckweed very suitable for toxicity tests (OECD, 2002), able to remove and accumulate large amounts of heavy metals, principally through the fronds (Zayed et al. 1998). Duckweeds are aquatic plants which often form dense floating mats in eutrophic ditches and ponds (Driever et al., 2005).Duckweed can be found world-wide on the surface of nutrient rich fresh and brackish waters (Zimmo, 2003). The nutrients taken up by duckweed are assimilated into plant protein. Under ideal growth conditions more than 40% protein content on dry weight basis may be achieved (Skillikorn et al., 1993).

2. Review of Literature

Duckweeds (family Lemnaceae) appear to be the better alternative and have been recommended for industrial effluent treatment, as they are more tolerant to cold than water hyacinth, more easily harvested than algae, and capable of rapid growth (Sharma & Gaur, 1995). According to Khellaf et al .2009, *L. minor*can tolerate heavy metal concentration at 0.4, 0.4, 3 and 15 mg/Lof metals Cd, Cu, Ni and Zn respectively. It proved that theaquatic macrophytes could survivein a medium containing 3 mg Ni/L or 15 mg Zn/L. Although thelevel of heavy metal can affectthe growth. The result shows that aquatic species could be a good candidate for cleaning up wastewaterpolluted with Zinc and Nickel (industrial and residential effluents). BRES at al 2012 conducted a comparative study for heavy metal removal efficiency for *lemna minor* and *Eichhorniacrassipes* for the removal of ni metal. The results clearly states that*lemna minor* can more effectively remove Ni metal as compared to the *Eichhorniacrassipes* at low metal concentration The removal percentages were 100%, 100% and 95% for 1, 3 and 6 mg l-1 respectively for *L. minor* at the end of the experiment. These results were found to be similar to those found by Axtell et al. (2003), who studied the removal of Ni in *L. minor* with different concentrations of Pb and they found similar removal. The results showed that this plant removed an 80 % and 87 % of Ni to 2.5 and 5 mg l-1 respectively.Bianconi et al 2013 investigated the toxic effects of Cd and its bioaccumulation on *L. minor*. The result found that *Lemna* showed a great capability of Cd absorption and accumulation in the fronds, which make it a potential plantin phytoremediation field. The combined data analysis of RGR, BCF, Ti and FV/FM indicates that *L. minor* showed a good capacity of growth, metal bioconcentration, tolerance and photosynthetic efficiency up to 48h in plants exposed to 13 and 22µM CdSO4. *Lemnaminor* can accumulate up to 1800 mg/kg on dry matter basis higher than 0.01% defined as threshold Cd concentration for hyper accumulator plants (Baker and Brooks 1989). Furthermore, in front of such high accumulation, *Lemna* showed a good protection of its photosynthetic apparatus as indicated by its Fv/Fm maintenance, up to 46µM CdSO4 after 24h. This result clearly shown that *L. minor* is a good cadmium accumulator and is able to remediate Cd-polluted waters, especially at low Cd concentrations.At different pHvalues in the range of 4-10, the removal of Pb and Ni in solution with *Lemna minor*was studied by Leela at el 2012. The maximum removal was found to be 99.99% for Pb at pH 5-6 and 99.3% for Ni at pH 6 after 28 days exposure. The study found that Pb removal was lowest (95.94%) at pH 10 after 7 days exposure treatments. In the same way the lowest Ni removal was achieved at pH 10 for 7 days treatments (73.78%). This states that alterations of the physiochemical conditions of the environment like pH can strongly influence the relative proportions of the metal ions that can be taken up by the respective plant. So, the study confirm the capacities of accumulation of lead and nickel by *Lemna minor* plant and its good potential for phyto remediation. The reason behind the removal from the medium was attributed to precipitation of metal salts, adsorption on the plants and absorption and sequestration inside the plant. *L. minor* could be used as an effective bio accumulator for the treatment of Pb and Ni containing wastewater. Another study conducted (Divya et al 2012) with *lemna minor* plant by providing Synthetic wastewater samples by using analytical grade Pb as Pb(CH3COO)2. 3H2O (MERCK) at nominal concentration of 10, 20, 30, 40 and 50 mg /L at temperature in the range of 20ºC to 28ºC and an experimental pH of solution which was manually maintained at the defined value with 0.1N NaOH and HNO3 for adjusted to 5, 6, 7, 8, and 9 demonstrated that the highest bioconcentration potential of Pb was observed by *Lemna minor* (0.900) at pH 6 and the minimum of 0.438 at pH 5, which make it an ideal plant for phytoremediation of wastewater laden with Pd originated from various industrial as well as domestic sources. The capacity of aquatic plant such as duckweed (*Lemna* sp.) to remove toxic heavy metals from water are well documented and plays an important role in extraction and accumulation of metals from wastewater. *L.minor* can remove up to 90% of soluble Pb from wastewater. Some characteristics e.g. *L.minor* can grow well in pH from 6 to 9 while the lowest value of pH it can tolerate in between pH 5-6 make it a suitable plant for phytoremediation. However, nitrate had few inhibitory on the growth (Chong et al., 2003).Mark R. Apelt 2010 also recommend *Lemnaminor* plant for removal of copper from the wastewater as *lemna minor* plant can effectively decrease copper upto55% of the total in only 9 days. *Lemna minor* was shown to be effective at remediating copper from an aqueous solution of municipally generated waste water. *Lemna minor* can be used as suitable flora species for phytoremediation of copper contaminated waste water. Duckweed (*Lemna minor*) found to remove effectively iron and copper at low concentrations in laboratory experiments (Jain et al., 1989) as well as cadmium (Wang et al.,2002). Common duckweed (L. minor) is a worldwide species which is commercially used in ecotoxicological laboratories and research(Vladimír DVOŘÁK et al 2012, Sandra Radic at al 2009). N. jafari and M. Akhavan 2011 conducted an comparative study of *lemna* species, with different level of Zn concentration e.g. 1,5,10,15 and 20 mg/l concentration for 10 days of exposure. *Lemna* minor showed an increased removal of Zn when the level of metal was increased. It results in 83% removal of Zn from the metal solution which shows it great removal potential of Zn contaminated wastewater.Toxicity of metal in *Lemna*tissue was found to be in decreasing order of damage: Zn > Ni > Fe > Cu > Cr >Pd (Horvat et al. 2007) when *Lemna minor* was exposed to electroplating wastewater. Uysal (2013) demonstrated with pilot system consisting of ponds with continuous water flow, like a natural and constructed wetland, that duckweed, *Lemna minor L.* could efficiently reduce chromium contents of water. It can accumulate chromium concentration upto 4.423mgCr/g when the pond operated at pH 4.0 and 5.0 mg Cr/L. As compared to algal test, *Lemna* test is considered as most suitable one to detect genotoxicity or toxicity (Stefan Gartiser et al. 2010). The plants possess physiological properties (small size, rapid growth between pH 5 and 9, and vegetative propagation) as well as detect inhibition of photosynthesis and also not get disturbed by waste water coloration, which make them an ideal test system for ecotoxicological testing (Redic et al. 2009, K.-J. Appenroth. 2009). Teixeira et al. (2013) also support the potential of *L. minor* for the bioaccumulation of iron which makes it an ideal plant for the bioremediation of mine effluent.

3. Conclusion

Natural systems, such as duckweed systems are yielding good effluent quality, in many situations at reduced costs and it is believed also at reduced environmental impact. Duckweed based systems fit into the new concept of recycling and cost recovery. Integrated systems of duckweed based wastewater treatment and fish aquaculture can recover a large part or possibly all the treatment costs if the system is applied to treat the domestic wastewater.More research is needed to address the further development of duckweed technologies. An important aspect is the possible health hazard associated with the use of wastewater grown duckweed as animal feed.It is an affordable technology utilizing plants as environmental cleansers in wastewater management.*L. minor* should be used in the bio monitoring of municipal, agricultural and industrial effluents because of their simplicity, sensitivity and cost-effectiveness.

4. References

1. Alaerts, G. J., Mahbubar-Rahma, M., and Kelderman, P. (1996). Performance Analysis of a Full-Scale Duckweed Covered Lagoon. Water Resources, 30, 843–52.
2. Axtell, N. R., Sternberg, S. P. K., and Claussen, K. (2003). Lead and Nickel Removal using Microspora and Lemna minor. Bioresource Technology, 89, 41-48.
3. Bianconi, D., Pietrini, F., Massacci, A., and Iannelli, M. A. (2013). Uptake of Cadmium by Lemna minor, a (hyper?-) Accumulator Plant Involved in Phytoremediation Applications. E3S Web of Conferences 1 13002 DOI:http://dx.doi.org/10.1051/e3sconf/20130113002
4. Hegazy, A. K., Kabiel, H. F., and Fawzy, M. (2009). Duckweed as Heavy Metal Accumulator and Pollution Indicator in Industrial Wastewater Ponds. Desalination and Water Treatment, 12 (1), 400-406.
5. Horvat, T., Vidakovic´-Cifrek, Z., Oresˇcˇanin, V., Tkalec, M., and Pevalek- Kozlina, B. (2007). Toxicity Assessment of Heavy Metal Mixtures by Lemna minor L. Science of the Total Environment, 384, 229–238.
6. Hou,W., Chen, X., Song, G., Wang, Q., and Chang, C. C. (2007). Effects of Copper and Cadmium on Heavy Metal Polluted Water body Restoration by Duckweed (Lemna minor) Physiology. Plant Biochemistry, 45, 62–69.
7. Jafari, N., and Akhavan, M. (2011). Effect of pH and Heavy Metal Concentration on Phytoaccumulation of Zinc by Three Duckweed Species. American – Eurasian Journal of Agricultural and Environmental Science, 10 (1), 34-41.
8. Jain, S. K., Gujral, G. S., Jha, N. K., and Vasudevan, P. (1988). Heavy Metal Uptake by PleurotusSajor-Caju from Metal Enriched Duckweed Substrate. Biological Wastes, 24, 275–282.
9. Kaur, L., Kasturi, G., and Sharma, S. (2012). Role of pH in the Accumulation of Lead and Nickel by Common Duckweed (Lemna minor). International Journal of Bioassaays, 1 (12), 191-195.
10. Khellaf, N., and Zerdaoui, M. (2009), Growth Response of the Duckweed Lemna minor to Heavy Metal Pollution. Iranian Journal of Environmental Health Science and Engineering, 6 (3), 161-166.
11. Loveson, A., and Sivalingam, R. (2013). Phytotoxicological Assessment of Two Backwater Wetlands in Kannamaly, Ernakulam Using Aquatic Macrophyte – Spirodelapolyrhiza. Journal of Environmental and Analytical Toxicology, 3 (180) .doi:10.4172/2161-0525.1000180
12. Naumann, B., Eberius, M., and Appenroth, K. J. (2007). Growth Rate Based Dose–Response Relationships and EC-Values of Ten Heavy Metals Using the Duckweed Growth Inhibition Test (ISO 20079) with Lemna minor L. clone St. Journal of Plant Physiology, 164, 1656–1664