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Abstract

,Q WKH SUHVHQW VWXG\ WKH HI¿FLHQF\ RI GXFNZHHG *Lemna minor* L.) as an effective na wastewater treatment was examined in an outdoor aquatic system. Duckweed plants were inoculated into wastewater DQG WDS ZDWHU V\VWHPV IRU WUHDWPHQW RYHU ¿IWHHQ GD\¶V UHWHQWLRQ SHU VDPSOHV ZHUH WDNHQ EHORZ GXFNZHHG FRYHU DIWHU ¿IWHHQ GD\V WR DVVHV water from different pollutants. For comparison, the plants were also grown in tubs containing tap water. The results show that concentrations of Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Copper (Cu), Zinc (Zn), Nickel (Ni), Chromium (Cr), Cadmium (Cd) and Lead (Pb) decreased by 93.4%, 99.9%, 93.9%, 98.5%., 91.9%, 85.0%, 95.0%, 90.0%, 99.8%, 99.5% and 95.0% respectively in waste water and subsequently these elements exhibited an increasing concentration in the plant body. Almost similar results were obtained when the plants were grown in tubs containing tap water. Biochemical parameters viz. chl-a, b, total-chl, carbohydrates and proteins as well as nutrient status of the macrophyte increased after the completion of the retention period both LQ ZDVWH DQG WDS ZDWHU 5HVXOWV FRQ¿UP WKDW GXFNZHHGV FDQ HIIHFWLYH

Keywords: *Lemna minor*; Wastewater; Retention period

Introduction

Multiple environmental factors in association with anthropogenic activities have signi cantly altered our aquatic ecosystems. Over use of chemical fertilizers and intensi cation of industrial activities

for the removal of contaminants from the environment are cheaper than the conventional remediation technologies [1]. In recent years, there has been a growing struggle to provide e cient, inexpensive, and environmentally friendly options for the remediation of trace elements and other contaminants in waste water. Moreover, aquatic plants are of special interest unlike the terrestrial plants, because they are capable of bio concentrating many nutrients and heavy metals in large quantities [2-4]. In Kashmir valley Anchar lake is one of the lakes

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reduction percentage of 85.0%, 95.0% and 90.0% respectively (Table 1). On the other side, these micronutrient (Cu, Zn and Ni) show high concentration in the plant body during the retention time with an increasing percentage of 34.69%, 69.44%, and 66.67% respectively i the plant body (Table 2). Similar results have been observed in tap water that was used for comparison purposes where micronutrients zinc and copper had decreased in concentration a er Lemna minor was grown in it for 15 days with a reduction percentage 100% and subsequently in plant body these nutrients have shown increasing percentage of 2.22% and 0.71% respectively (Table 2) however nickel has shown no change as it was not observed in tap water during initial analysis. In the line of present study Wa a et al. [17] reported that duckweed treatment system reduced zinc by 93.6% and copper by 100% during eight days retention period. Zaltauskaite et al. [15] also found that Zn was most e ciently removed, depending on the initial Zn concentration Lemna minor removed between 42.3-77.8% of Zn. ey also found that a er the 7 days of e uents exposure to Lemna minor treatment, the concentration nickel was reduced signi cantly.

e major cause of micronutrient reduction in waste water / tap water was utilization by the Lemna minor plant for body formation and development. Duckweeds require a number of macro and micronutrients for their normal growth. Nutrients are absorbed through all surfaces of the duckweed leaf. DWRP [18] reported that the highest growth rate for Lemnaceae under optimal laboratory conditions is about 0.66 generations per day that is equal to a doubling time of 16 hours. It has been reported that duckweeds generally double their mass in 16 hours to 2 days under optimal conditions which further helps in uptake of nutrients from the growing media for developing body tissue. As also reported by Korner and Vermaat [19] that the nutrients removed by duckweeds from growing media are mainly realized by newly grown tissue of the plants. Duckweed has a high mineral absorption capacity and can tolerate high organic loading as well as high concentrations of micronutrients.

Heavy metals (Cd, Cr and Pb)

e concentrations of heavy metals such as Cd, Cr and Pb reduced a er Lemna minor was grown on wastewater for 15 days retention period. ese metals have reached their minimum concentration of 0.001, 0.001 and 0.01 mg l^{-1} respectively with a reduction percentage of 99.5%, 99.8% and 95.0% respectively, however in plant body their concentration has increased during the study period with an increasing percentage of 92.06% 43.59% and 0.52% respectively. In case of tap wat cadmium and lead were not observed during initial analysis however chromium had decreased in concentration from 0.20 ppm to 0.00 ppm 73 (, h)4 (o)16 (w)8 (e)-8 (v)84 Tw T* [(pcs)-8 (er)-29 (v)tio 327.4

in plant body chromium have shown increasing percentage of 3.23%, whereas cadmium and lead have shown no change in their initial concentrations (Table 2). In concurrence with the present ndings, Wa a [17] studied that duckweed aquatic treatment system performed 100% lead and 66.7% of cadmium removal from wastewater a er 8 days treatment period. Similar results have also been found by Kara et al. [20] and concluded that duckweed Lemna mi Lnor to take up Pb, Cu, Fe, Cd and Ni from contaminated solutions. Removal of heavy metals from

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