International Journal of Academic Multidisciplinary Research (IJAMR)
ISSN: 2643-9670
Vol. 6 Issue 4, April - 2022, Pages:169-171

Zinc Bioaccumulation in Some Potamogetonaceae Species

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Abstract: *This study was carried out to determine Zn accumulation capacity of Potamogeton pectinatus, Potamogeton perfoliatus and Groenlandia densa, grown in single and triple. The macrophytes used in the study were collected from the wetlands in Gaziantep and brought to the laboratory. 0, 5, 25 and 50 mg/L concentrations of Zn were applied to healthy macrophytes acclimated in a controlled climate chamber. It was determined that Zn content of macrophyte tissues grown under the effect of single and triple Zn concentrations increased with increasing the metal concentrations. Considering both applications, the Zn content of the macrophytes was found as G. densa>P. perfoliatus>P. pectinatus Besides, macrophytes have been found to accumulate more Zn in their tissues in single applications. In addition, the bioconcentration factors of macrophytes were calculated to decrease with increasing Zn concentration.*

Keywords— Bioaccumulation, zinc, *Groenlandia densa*, *Potamogeton pectinatus*, *Potamogeton perfoliatus*

INTRODUCTION

Metals in aquatic environments can be contaminated due to both natural and anthropogenic reasons. Heavy metal contamination in the environment has become a major problem due to excessive industrial activity Large areas are contaminated with heavy metals such as Zn, Cd, Pb and Cu due to sewage or urban compost, pesticide and fertilizer use, municipal waste, car exhaust, mining waste and metal melting industries (Bewley, 1980; Novotny, 1995). Zinc is a heavy metal with metabolic functions in living things. In addition to participating in protein and carbohydrate synthesis, it also has effects on enzyme activation, photosynthesis, respiration and biological membrane stability (Rout and Das, 2003). It is an important element used in metal plating and alloys in industry. Moreover; It is used in many industries such as ink, copy paper, cosmetics, paint, rubber, linoleum, mining industry. Zinc reaches the soil through wastewater, sewage water and acid rain left from intensive industrial areas (Vaillant et al., 2005). Zn concentrations in plants are between 5-100 ppm in normal plants, and its toxic effects on plants generally begin after 400 ppm (Özbek et al., 1995).

Aquatic macrophytes include seed and seedless plants that live in streams such as rivers and stagnant waters such as lakes. (Doğan, 2011). It has been found that submers macrophytes living in wetlands accumulate metals at high concentrations in their roots and shoots (Greger, 1999; Fritioff and Greger, 2001). In general, it has been revealed by the studies that submers macrophytes accumulate more heavy metals than the macrophytes with emers and floating leaves. Saygideger and Dogan (2005) determined the metal accumulation levels in macrophytes collected from the Seyhan River (Adana-Turkey), and determined that submers macrophytes (*Myriophyllum spicatum*, *Potamogeton crispus*, *Potamogeton pectinatus*) accumulate more Pb, Cd, Cu and Zn in their structures compared to emers type macrophytes (*Typha latifolia*, *Phragmites australis*).

This study was carried out to determine the Zn accumulation capacities of three different macrophytes (*P. pectinatus*, *P. perfoliatus* and *G. densa*) belonging to the Potamogetonaceae as a result of single and triple applications.

MATERIAL AND METHOD

The macrophytes used in the study were collected from the wetlands of Gaziantep province. For two weeks, these macrophytes were acclimatized in 10% Arnon and Hoagland (1938) nutrient solution in the air-conditioning cabinet at 23–25°C, 16 hours of light (6000 μE $m^{-2}.s^{-1}$) and 8 hours of darkness. Healthy macrophytes were exposed to concentrations of 0, 5, 25 and 50 mg/L of Zn with 10% nutrient solution in 1000 ml containers individually and in triplicate. After 96 hours, the harvested macrophytes were washed thoroughly with distilled water and dried at 80°C until constant weight.

The Zn content of dried and ground macrophyte samples was determined using an AAS device (Perkin Elmer AAnalyst 400) following wet digestion (HNO_3-HCl). Zn contents of the macrophytes were calculated as mg/kg dry weight.

Bioconcentration factors (BCF) of macrophytes were calculated by the ratio of Zn in the tissues of macrophytes to the Zn concentration in the application solutions.

Statistical analysis of the obtained data was performed using the SPSS 11.0 package program. One-Way ANOVA LSD test was applied to determine which group or groups were different.

RESULTS AND DISCUSSION

It has been determined that the Zn content of macrophyte tissues grown as single and triple at different concentrations of zinc increases with increasing metal concentration. Accordingly, in single macrophyte applications of Zn at 5, 25 and 50 mg/L Zn concentrations, the zinc content was 2.8, 3.2 and 5.1 ($p<0.05$) times for *P. pectinatus*, 2.2, 2.3 and 2.8 times for *P. perfoliatus* and for *G. densa* 3.2, 5.8 and 8.4 ($p<0.05$) times increased, respectively, compared to the their controls. (Fig. 1). It has been found that the roots and shoots of submers macrophytes collected from wetlands accumulate metals at high concentrations (Fritioff and Greger, 2001). The metal concentration in the tissues of plants varies between plant species and tissues. According to our research findings, it has been determined that *G. densa* can accumulate much more Zn in its tissues compared to *P. pectinatus* and *P. perfoliatus* in both macrophyte applications. Controls of these macrophytes collected from the same habitat were found to accumulate metals in a similar way. Sawidis et al. (1995) reported that even species belonging to the same genus and in the same habitat may have different heavy metal accumulation capacities, which also supports our findings. The reasons for this may be due to cellular metal ion uptake and/or anatomical and morphological differences of macrophytes (Denny, 1980).

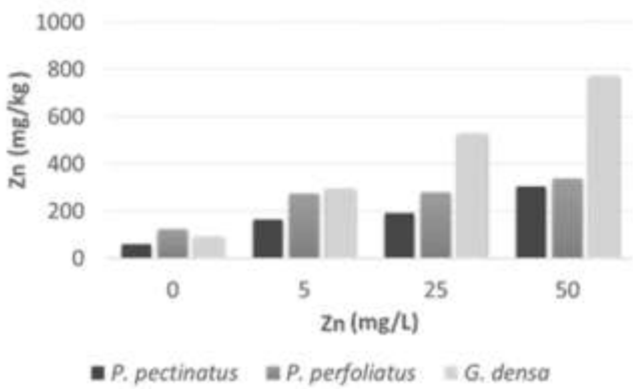

Fig. 1. **Zn contents of individually applied macrophytes**

Metal accumulation capacities of macrophytes may vary depending on the plant species and the conditions of their environment. These differences may be caused by factors such as the physico-chemical properties of the environment and the structure of the macrophyte (Doğan, 2011). When single macrophyte treatments were compared, the Zn contents of macrophytes at 5, 25 and 50 mg/L increased 2.2, 3.0 and 4.4 ($p<0.05$) times for *P. pectinatus*, 1.8, 1.9 and 2.6 times ($p<0.05$) for P. perfoliatus and 2.5, 3.7 and 5.0 ($p<0.05$) times for *G. densa*, respectively, compared to their controls (Fig. 2). As a result, it was determined that macrophytes accumulated more Zn in a single application compared to triple macrophyte application.

The bioconcentration factor (BCF) was calculated to determine the capacity of macrophytes to accumulate Zn. Therefore, BCF is particularly important as it provides quantitative information about the ability of plants to absorb bioaccumulative contaminants such as heavy metals from water. In both single and triple macrophyte applications, it was determined that the BCF decreased with increasing Zn concentration (Fig. 3 and 4). Besides, the highest BCFs were determined in *G. densa*. Thus, this may indicate that *G. densa* is a good Zn accumulator compared to other tested macrophytes.

As a result, it was determined that the Zn accumulation levels of these macrophytes belonging to Potamogenonaceae were different in single and combined (triple) applications. Among the macrophytes tested, *G. densa* was found to be a good Zn accumulator. As a result of anthropogenic activities, heavy metal contamination is gradually increasing in our environment. Removing pollutants of aquatic macrophytes from the environment can have a reducing effect on environmental pollution. In addition, aquatic macrophytes are also important in terms of reflecting the pollution levels of the metals in their environment.

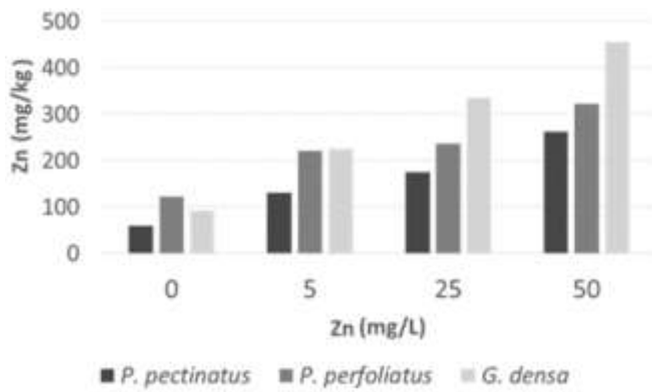

Fig. 2. **Zn contents of triple applied macrophytes**

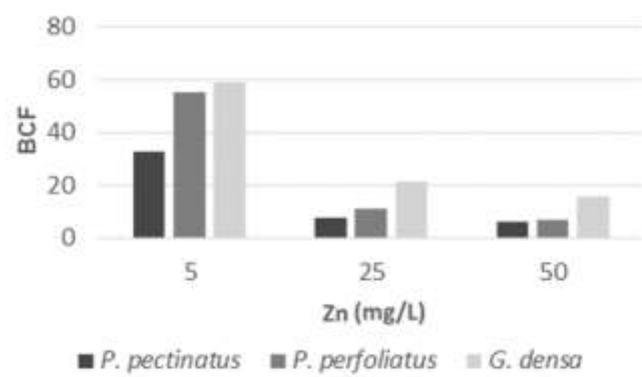

Fig. 3. **BCFs of individually applied macrophytes**

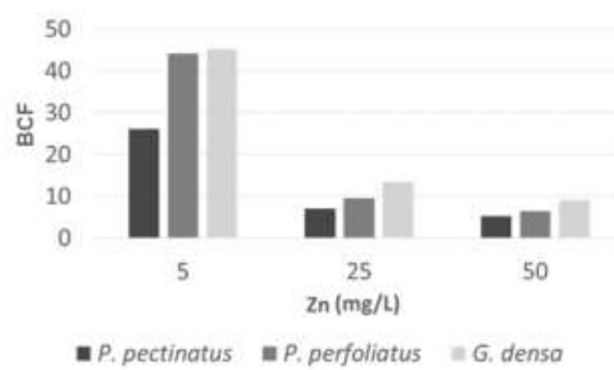

Fig. 4. **BCFs of triple applied macrophytes**

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