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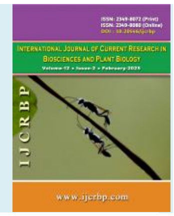

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Effect of cadmium toxicity on morphological parameters of *Pistia stratiotes*

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Abstract

Pistia is a genus of aquatic plant in the arum family, Araceae. The experimental plant is selected based on the availability and adoptability of the plant. The experimental plant is used to treat swellings and urinary tract infections. The leaves are diuretic, emollient, expectorant, laxative and stomachic, etc. The aim of this study is to determine cadmium toxicity on morphological index parameters (MID) in submerged aquatic macrophyte *Pistia stratiotes*. The experimental samples were collected from Hullikeri Lake of Koppal. The plants were maintained under laboratory conditions with different concentrations of Cadmium salts to understand its effect on morphological characters of the plant. It was observed that, the maximum shoot length (6.65 cm) and root length (4.53 cm) in the plants treated with 1.5 mg/liter cadmium salt compared to other treatments. The plant treated with 2.5 mg/liter showed decreased plant growth responses. Therefore, it is concluded that, higher concentration of heavy metal affects plants and the optimum amount of heavy metal can be removed from the contaminated water bodies by using the experimental plant.

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Introduction

Heavy metal contamination in water bodies is developing at an alarming rate because of industrial and human activities (Devi and Prasad, 1998; Meagher 2000). Heavy metal toxicity in hydrilla has also been examined (Singh et al. 2013). Researchers have looked into how heavy metals alter chlorophyll content (Gupta et al., 1996). Heavy metals cannot be decomposed; thus, continuing research is being conducted to develop systems that use biological materials to effectively remove heavy metals from the environment. In this regard, it has been noticed that many plants accumulate heavy metals. According to Singh et al. (2013) and Sinha et al. (2009), higher plants have physiological adaptations that allow them to withstand and accumulate heavy metals.

Different cadmium concentrations were found to have an unfavourable influence on chlorophyll production (Somashekaraiah et al., 2006, 1992; Sune et al., 2007). When metals accumulate in large quantities, they inhibit growth, disrupt metabolic processes, and create SH group enzymes. Therefore, the current study was conducted to assess the impact of various cadmium concentrations on aquatic macrophyte.

Pistia is an aquatic plant genus belonging to the Araceae family. *Pistia stratiotes*, a single species, is also known as water cabbage, water lettuce, Nile cabbage, or shellflower. Although its natural distribution is unknown, it is most likely pantropical; its initial discovery was in the Nile near Lake Victoria, Africa. It is currently prevalent in nearly all tropical and subtropical freshwater streams, both naturally and through human introduction. It is considered an invasive species and a mosquito-breeding environment. The genus name is derived from the Greek word (pistos), which means "water," and indicates the aquatic character of the plants.

We used an experimental plant which is used to treat inflammation and urinary tract infections. Its leaves possess diuretic, emollient, expectorant, laxative, and stomachic properties. It is commonly used to treat dysuria and stomach disorders. To treat dysentery, people blend them with rice and coconut milk; to treat coughs and asthma, they combine rosewater with sugar. People use the leaves to treat gonorrhoea, most likely because of their diuretic effects. The leaves are applied externally to cure skin ailments such as boils, piles, and syphilitic sores. They are also used in the treatment of haemorrhoids. The roots are used externally to cure burns. They were mashed and placed in a poultice. When using this plant, exercise is cautious, and an overdose may induce extreme diarrhoea. The purpose of this study was to determine the toxicity of cadmium to the submerged aquatic macrophyte *Pistia stratiotes* using morphological index parameters (MID).

Materials and methods

Sample collection and processing

Pistia is an aquatic plant that thrives in stagnant ponds, lakes, and water bodies. Plant samples for this experiment were taken from Hullikeri pond near Malemahadeshwara fort. A uniformly sized plant, *Pistia*, was gathered from Hullikeri Pond and transported to the laboratory (room). The plants were cleansed with tap water (Fig. 1).

Treatments

*Pistia stratio*tes L. is grown in the wide plastic pots (each about 5 cm in diameter) at 280-300°C with about 15 g of young, vigorous plants. It is then acclimated for 30 days in nutritional solution with a pH between 7.1 and 7.4. These treatments were kept throughout the experiment (Fig. 2).

- Control without cadmium salt solution (0 ml)
- Plants with 0.5 ml cadmium salt solution
- Plants with 1.0 ml cadmium salt solution
- Plants with 1.5 ml cadmium salt solution
- Plants with 2.0 ml cadmium salt solution
- Plants with2.5 ml cadmium salt solution

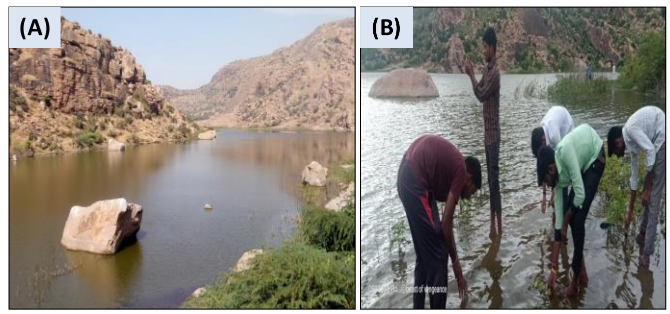

Fig. 1: (a) Hullikeri Lake and (b) *Pistia stratiotes* L., collection at Hullikeri Lake.

Fig. 2: Experimental set up: plants maintained in plastic pots.


Fig. 3: Plants treated with different concentration of Cadmium salts uprooted for shoot and root length measurement.

Observations

The room temperature ranged from 25-30° C during the day to 15-20° C at night (6:8 light: dark photoperiod), with a relative humidity of 75-85%. Throughout the trial, we manually watered the plants with the required tap water. Morphological index parameters (MIP) such as root length, shoot length, shoot fresh weight, root fresh weight, root dry weight, and shoot dry weight were measured at 45 and 60 days into the experiment (Fig. 3).

Results and discussion

Different amounts of Cd salt (0.5, 1.0, 1.5, 2.0, and 2.5) had different effects on *Pistia stratiotes* L. The maximum shoot length (6.65 cm) and root length (4.53 cm) were observed in the plants treated with 1.5 mg/l cadmium salt compared to the other treatments. In addition, the fresh and dry weights of the *Pistia* shoots were highest for the 1.5 mg/l treatment (14.32 g and6.2 g), and the fresh and dry weights of the *Pistia* shoots were highest for the 9.512 g and 7.23 *g* (Table 1). Plants treated with 2.5 mg/l showed decreased plant growth compared to other treatments because high concentrations of cadmium inhibit plant growth.

Table 1. Effect of cadmium on growth parameters of *Pistia stratiotes* L., at 45 days after treatment.

Cadmium (mg/l)	SL (cm)	SFW (g)	SDW (g)	RL (cm)	RFW (g)	RDW (g)
0	2.023±0.05	7.321±0.15	8.01±0.02	3.25±0.09	5.23±0.08	2.05±0.08
0.5	2.52 ±0.06	9.92±0.12	4.52±0.12	3.92±0.04	6.02±0.15	3.99±0.05
1.0	4.50 ±0.03	11.63±0.04	5.89±0.13	4.12±0.15	8.13±0.03	6.85±0.08
1.5	6.65±0.07	14.32±0.10	6.21±0.05	4.53±0.05	9.51±0.10	7.23±0.03
2.0	3.52±0.04	11.12±0.05	5.25±0.08	3.58±0.12	8.11±0.12	5.26±0.11
2.5	2.13±0.15	9.23±0.08	4.81±0.10	2.92±0.10	6.25±0.15	3.85±0.05

Note: SL: Shoot Length, SFW: Shoot Fresh Weight, SDW: Shoot Dry Weight, RL: Root Length, RFW: Root Fresh Weight and RDW: Root Dry Weight.

Table 2. Effect of Cadmium salt on growth parameters of *Pistia stratiotes* L., at 60 days after treatment.

Cadmium (mg/l)	SL (cm)	SFW (g)	SDW (g)	RL (cm)	RFW (g)	RDW (g)
0	3.21±0.15	7.94±0.09	8.91±0.03	3.96±0.03	7.01±0.04	4.02±0.07
0.5	3.98±0.11	10.23±0.02	5.55±0.02	4.65±0.06	8.27±0.09	7.25±0.09
1.0	4.81±0.09	12.62±0.07	6.86±0.04	5.13±0.01	10.23±0.11	7.92±0.12
1.5	7.23±0.02	15.89±0.11	7.99±0.09	5.95±0.03	11.56±0.12	6.25±0.18
2.0	4.23±0.05	12.58±0.06	6.38±0.07	4.58±0.10	8.42±0.06	4.96±0.03
2.5	2.81±0.02	10.91±0.04	5.86±0.06	3.21±0.12	7.35±0.07	4.38±0.02

Note: SL: Shoot Length, SFW: Shoot Fresh Weight, SDW: Shoot Dry Weight, RL: Root Length, RFW: Root Fresh Weight and RDW: Root Dry Weight.

At 60 days after treatment, the plants responded as shown at 45 days after treatment. Compared to other plants, those treated with 1.5 mg/l cadmium salt showed the most growth responses. On the other hand, those treated with 2.5 mg/l cadmium salt showed the least growth responses (Table 2). Higher concentrations of Cd negatively affected plant growth parameters.

The present experiments are similar to the findings of Kumar et al. (2019); Vestina et al. (2011) and Wang et al. (2010). They investigated the effects of adding varying amounts of cadmium to mung bean seedlings that were in the process of sprouting. The results showed that seedling chlorophyll and home levels decreased significantly. This was because lipoxygenase causes lipid peroxides to build up, and free radical scavengers, such as superoxide dismutase and catalase stop working.

Aquatic hydrophytes are the most effective plant species for heavy metal accumulation. These experiments yielded similar results. These findings are consistent with previous reports on different aquatic plants (Li et al., 2013 and Mufferege et al., 2010 and Maine et al., 2009). They looked at how poorly nickel and phosphorous were taken up, where they were found in the tissues over time, and how air pollution changed the shape of *Eichhornia crassipes* inside and outside. Despite its toxic effects, *Eichhornia crassipes* efficiently accumulates Ni, probably because of the morphological plasticity of its root system (Stratford et al., 1984).

Conclusions

The study demonstrates that cadmium concentration significantly influences plant growth responses. Plants treated with 1.5 mg/l cadmium salt exhibited the most favourable growth outcomes, while those exposed to 2.5 mg/l cadmium salt showed the least favourable responses. These findings, consistent across both 45 and 60 days after treatment, suggest that higher concentrations of cadmium negatively impact plant growth parameters. These results contribute to our understanding of plant responses to cadmium stress and highlight the potential of aquatic plants for phytoremediation of heavy metal-contaminated environments. Further research is needed to explore the mechanisms of metal tolerance and accumulation in these plants for potential applications in environmental remediation.

Conflict of interest statement

Authors declare that they have no conflict of interest.

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