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Effects of Cd and Pb on physiological characteristics of *Schoenoplectus litoralis* and *Elodea canadensis*

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Abstract
The current study was designed to investigate the effects of cadmium and lead on physiological characteristics of *Schoenoplectus* L. and *Elodea C.* It was used three different concentrations (10, 20, 30) mg/liter of cadmium chloride and lead chloride during 30 days. The results of study was the aquatic plant *Elodea canadensis* has a higher accumulation of cadmium chloride in its tissues than *Schoenoplectus litoralis*, while *Schoenoplectus* L. has a higher accumulation of lead chloride in its tissues than *Elodea C.* lead chloride and cadmium, which have an impact on reducing the amounts of protein and chlorophyll in *Schoenoplectus* L. and *Elodea C.* The purpose of this study was to investigate the effects Cd and Pb on the physiological traits and growth of *Schoenoplectus* L. and *Elodea C.*

Keywords: Cadmium and lead, physiological, *Schoenoplectus* L. and *Elodea C*

Introduction
As industrialization has progressed quickly, environmental pollution and ecological harm have gotten worse. Pollution from heavy metals and water has emerged as two of the world's most significant environmental issues. Because of their high concentration of heavy metals, perennial characteristics, large biomass output, and quick development, water plants have shown to be an efficient way to remove or stabilize harmful metals from contaminated water [1]. Heavy metals are among ninety-five substances that are classified as harmful materials that are released into water, sediments, and the soil environment. Heavy metals are produced as byproducts of most human activities in the natural environment [2]. The ecology is contaminated by the various heavy metals released by transportation vehicles and refinery businesses [3]. Lead is found in both terrestrial and aquatic environments as a result of various anthropogenic activities. Lead is thought to be responsible for roughly 10% of all heavy metal pollution [4]. Silver-white and poisonous, Cadmium is a metal element, it can be readily absorbed by plant roots because to its water solubility, fluidity, and toxicity. It can also change the structural and functional characteristics of plants, prevent seed germination, and lengthen their roots [5]. Plant metabolism is hampered by the direct or indirect inhibition of physiological functions by copper, including respiration, photosynthesis, water transport, and gas exchange. Furthermore, by causing an increase in reactive oxygen species (ROS), Cd can disrupt the antioxidant defense system and have an impact on a plant's metabolism and chlorophyll synthesis [6]. The normal growth of plants can be impacted by the absorption and accumulation of Cd. Cd stress results in a decrease in the biomass and photosynthetic rate of plants, as well as oxidative damage and an imbalance in nutrient uptake employing lichens as chelating agents and bioindicators for several decades [7]. Lichens were used as a bioindicator to report on distinct Pb isotopes over a period of decades [8]. Apart from the conventional lead contamination sources that haven't been completely eradicated in society, like paint, toys, traditional medicines, ceramics, and certain industries like lead ore smelting and fertilizer, the bioaccumulation process also occurs through uptake, bioavailability, bioconcentration, and biomagnification [9]. In order to absorb heavy metals in their intracellular space, living things (microorganisms) use importer complexes, which open a translocation pathway through the lipid bilayer [10]. This metabolically active process is known as bioaccumulation. Once inside the intracellular area, proteins and peptide ligands—that is, storage systems seen in plants—can sequester the HM [11, 12].

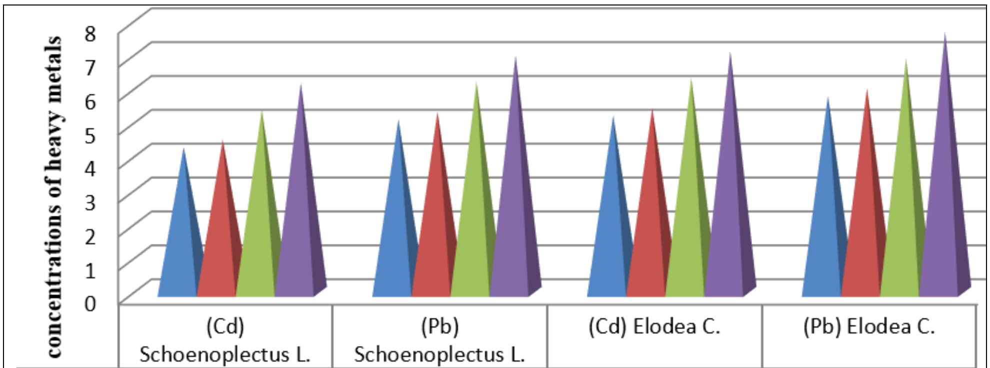
Via cellular respiration or capillary action, the plants collect the free Pb ions from the air and absorb them [13]. Lead enters the plant system after being immediately absorbed into the soil from the surrounding atmosphere. Divalent free-Pb cations are taken up by plants' well-developed root systems along with nutrients [14]. The xylem vessels subsequently carry these adsorbed lead ions. Along with other dissolved nutrients, the heavy metal translocates through the plant system along the xylem vessels in an upward flow, where it is unloaded into the endoderm. Additionally, because plant leaves have a vast surface area, metal ions from contaminated air can be absorbed by the cuticle and stomata, which causes chlorosis in leaves that is attached to the cell wall and plasma membrane and occurs parallel to the endodermis region [15]. When they get to the endodermis section of the plant, they form a tight bond with the plasma membrane and cell wall. Using plants' innate capacity to concentrate elements and chemicals from their surroundings and to detoxify a variety of contaminants, phytoremediation is a low-cost, plant-based remediation method. Certain plants, known as hyper-accumulators, have the capacity to bio-accumulate chemicals, which results in the concentrating effect [16]. Phytoremediation initiatives worldwide have mitigated contaminants such as metals, herbicides, solvents, explosives, crude oil and its derivatives, static water, and contaminated soil [17]. Metals can be extracted from environmental pollution using phytoremediation technology, and certain species can accumulate extremely high concentrations of toxic metals in their tissues. The purpose of this study was to look at how Cd and Pb affected the physiological traits and growth of *Schoenoplectus* L. and *Elodea C.*

Materials and Methods

The research study was designed to determine the ability of some aquatic plants, such as *Schoenoplectus* L. and *Elodea C.*, to remove some heavy metals. A weight of 500 grams was used for each plant, and they were grown individually in plastic containers with a capacity of 15 liters. Each container contained 10 liters of water contaminated with three different concentrations (10, 20, 30) mg/liter of cadmium chloride and lead chloride [18]. The study continued for a month according to the required test, and samples were taken every 10 days. Plant samples were collected from the ponds for the purpose of estimating the concentrations of heavy metals and the amount of chlorophyll and protein. The protein level in plant tissues was determined according to method [19], and the total chlorophyll content in aquatic plant tissues was estimated according to method [20].

Results and Discussion

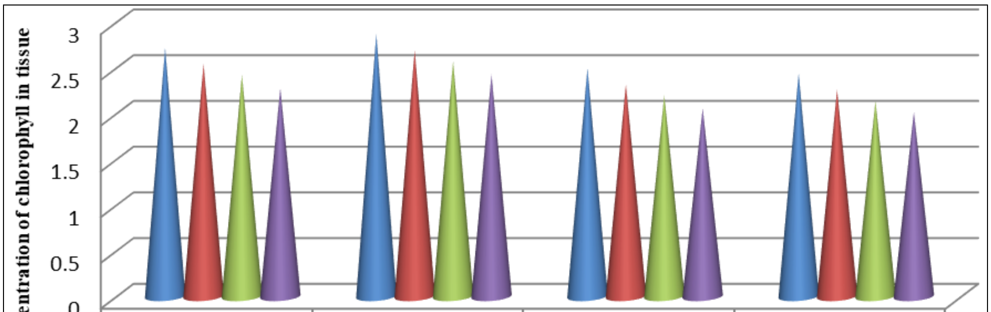
Figure (1) shown accumulation of cadmium chloride and lead chloride (6.182 and 7.002) compared with the control (4.287 and 5.107) respectively in the aquatic plant *Schoenoplectus* L. tissues where concentrations of cadmium chloride and lead chloride in the aquatic plant *Elodea C.* tissues (7.116 and 7.694) compared with the control (5.221 and 5.799) respectively. In other words, the aquatic plant *Schoenoplectus* L. has a higher lead chloride accumulation than the aquatic plant *Elodea C.*, but the aquatic plant *Elodea C.* has a higher accumulation of cadmium chloride in its tissues. This suggests that the aquatic plants under investigation are able to retain this material in their tissues, or that they have developed a special tolerance to a significant number of elements, or that they absorb high concentrations of elements that eventually turn into dormant forms of gaps [22]. Differences in plant species, physiological states, and element receptivity may account for fluctuations in the concentration of elements gathered within plant bodies [22]. According to the sources, plants exposed to heavy metals grow plant clams, which prevent the plants from eliminating toxins and preserving a balanced concentration of heavy elements in the environment. Because it employs glutathione as a base material to activate the presence of heavy ions, the enzyme phytochelatin synthase is to blame for this [23] noted that a range of environmental factors, including temperature, light intensity, salinity, pH level, and the effectiveness of complex organic and inorganic compounds, as well as their effects on physical and chemical processes that control the rate at which heavy metals accumulate in an organism's tissues, as well as metabolic processes, Further factors influencing bioaccumulation are the element's concentration in the natural environment and its physical properties [24].



	(Cd) Schoenoplectus L.	(Pb) Schoenoplectus L.	(Cd) Elodea C.	(Pb) Elodea C.
control	4.287	5.107	5.221	5.799
10ppm	4.504	5.324	5.438	6.016
20ppm	5.392	6.212	6.326	6.904
30ppm	6.182	7.002	7.116	7.694

Fig 1: Concentrations of Cd & Pb in *Schoenoplectus* L. and *Elodea C.* tissues

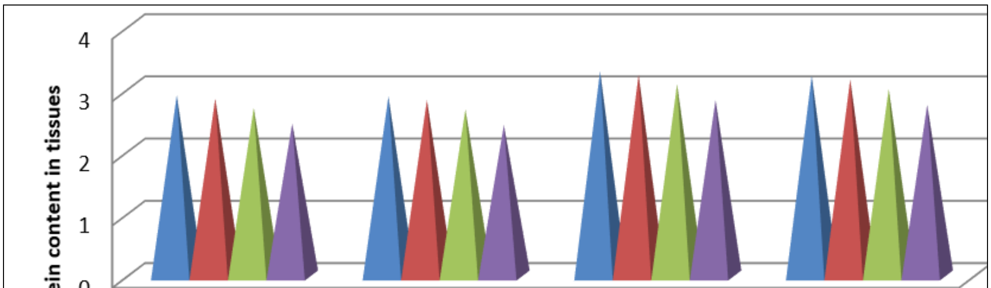
Figure (2) shown the concentration of chlorophyll in the aquatic plants *Schoenoplectus* L. in concentration 30 ppm of cadmium chloride and lead chloride (2.278 and 2.429) compared with the control (2.719 and 2.871) respectively where concentrations of cadmium chloride and lead chloride in the aquatic plant *Elodea C.* tissues (2.058 and 2.016) compared with the control (2.497 and 2.438) respectively. The decrease in chlorophyll concentrations in the experimental plants can be attributed to these extremely dangerous substances, which have the capacity to build up in plant tissue [25]. It stops the synthesis of porphyrin by blocking the actions of the enzymes that cause it, such as aminolevulinic acid dehydratase and porphobilinogen deaminize [26]. Studies have indicated that specific heavy metals can be affected by the production of chlorophyll, the process of photosynthesis, and the creation of other colors like efficacy and carotenoids [27]. These elements have the following effects on the enzymatic system, It was discovered by [28] that there were significant differences at the probability level ($p<0.05$) between the total protein and chlorophyll in the tissues of the plants utilized in the experiment and exposed to the different concentrations of heavy elements used throughout the experiment. This could be because the enzymes involved in the production of carotene and chlorophyll are blocked when the concentration of heavy metals in plant tissues rises [29]. This causes a decrease in the amount of chlorophyll in the plant tissues. A few enzymes that help in the production of chlorophyll are installed by Nasser [30].



	(Cd) Schoenoplectus L.	(Pb) Schoenoplectus L.	(Cd) Elodea C.	(Pb) Elodea C.
control	2.719	2.871	2.497	2.438
10ppm	2.542	2.694	2.32	2.261
20ppm	2.421	2.572	2.199	2.138
30ppm	2.278	2.428	2.058	2.016

Fig 2: Concentration of chlorophyll in *Schoenoplectus* L. and *Elodea C.* tissues

Figure (3) shown The protein levels in *Schoenoplectus* L. in concentration 30 ppm of cadmium chloride and lead chloride (2.445 and 2.420) compared with the control (2.901 and 3.879) respectively in the aquatic plant *Schoenoplectus* L. tissues where concentrations of cadmium chloride and lead chloride in the aquatic plant *Elodea C.* tissues (2.824 and 2.747) compared with the control (3.286 and 3.212) respectively. The reasons for the decline in all plants' protein content, which reduces the proportion of protein content in their tissues, are either the consumption of the protein content in these plants' tissues for specific essential activities or the metabolic processes that occur within them to withstand the concentration of the elements [31]. This fraction decreases as exposure duration increases until the event ends [32].



	(Cd) Schoenoplectus L.	(Pb) Schoenoplectus L.	(Cd) Elodea C.	(Pb) Elodea C.
control	2.901	2.879	3.286	3.212
10ppm	2.846	2.823	3.229	3.154
20ppm	2.698	2.674	3.079	3.003
30ppm	2.445	2.42	2.824	2.747

Fig 3: Protein content in *Schoenoplectus L.* and *Elodea C.* tissues

Conclusion and Recommendations

In comparison to *Schoenoplectus* L., the aquatic plant *Elodea C.* exhibits a greater accumulation of cadmium chloride and lead chloride in its tissues. Conversely, *Schoenoplectus* L. exhibits a higher accumulation of cadmium chloride and lead chloride in its tissues than *Elodea C. Schoenoplectus* L. and *Elodea C.*'s levels of protein and chlorophyll were most significantly lowered by the metals. When selecting plant species, the type of contaminant and its concentration in the environment are taken into account because plants are an effective biological tool for removing toxins from heavily polluted areas.

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