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Typha: an Aquatic Macrophyte with Potential Use in Phytoremediation of Wastewater

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ABSTRACT

As a negative consequence of industrial as well as anthropogenic activities produces heavy metals which are mobilized from their natural reservoirs to the atmosphere, soil and water. The existing purification technologies used to remove contaminants are too costly and are not eco friendly as well. Therefore, the research oriented towards phytoremediation which is low cost and eco friendly technology for water purification. Both terrestrial and aquatic plants have been tested to remediate contaminated wastewaters. Aquatic plants plays important role in balancing water bodies. They can acquire remove heavy metals contamination from the surrounding water. Typha exhibit capacity for removing contaminants such as heavy metals, inorganic nutrients etc. from wastewaters. Hence, Properties such as high productivity, high sorption capacity and high metal removal potential establish Typha as an aquatic macrophyte with immense potential for use in phytoremediation technology. This review discusses the general performance and potential of Typha species in purifying water and waste water.

Keywords- *Heavy metals, Phytoremediation, Typha and Wastewater.*
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INTRODUCTION

Extensive pollution of fresh water is posing a serious and growing threat to sustainable development as well as protection of the environment. Human health, agricultural development, industrial development and the ecosystems are all at risk, unless water and land systems are effectively managed [1]. The presence of various heavy metals in the water and land systems causes serious concern in nature as they are non biodegradable and may accumulate at high levels [2].

Industrial effluents as well as household wastes may be discharged directly into the sea, or into waterways or sewer but whatever the disposal route, these constitute an important source of contamination of the environment. Various conventional methods used for the removal of heavy metals from wastewater include chemical precipitation, ion exchange and reverse osmosis etc. Moreover, these methods are specific to each metal ion. New technologies are required that can reduce heavy metal concentrations to environmentally acceptable levels at affordable costs So, the search for a new, simple, effective and eco-friendly technology involving the removal of toxic heavy metal from wastewater has directed attention towards phytoremediaton. Both terrestrial and aquatic plants have been tested to remediate contaminated wastewaters Aquatic plants plays important role in balancing water bodies. Vascular macrophytes may accumulate considerable amounts of heavy metals in their tissues [3]. In the recent past years, several of the submerged, emergent and free-floating aquatic macropytes are reported to bioconcentrate heavy metals in natural waters as well as after exposure to wastewaters [4].

Among various species, *Typha* is the most widespread water weed around the world belonging to the Typhaceae family. These plants have the advantages of growing under varied climatic conditions and accumulate heavy metals under natural conditions or from contaminated environments. Several species of *Typha* including T. *angustifolia L.* [5], *T. dominengensis* [6] , *T. orientalis C.* [7] and *T. latifolia L.* [8] appears to be highly adaptable and establish easily in most regions and show potential to remove various contaminants including heavy metals from wastewaters.

Heavy metals removal

Heavy metal contamination in aquatic and soil environments is a serious environmental problem, which threatens aquatic ecosystems, agriculture, and human health [9, 10, 11, 12].

Aquatic macrophytes, being the principal mechanism for metal uptake and adsorption through roots, have been used during the last two decades for metal removal from water, competing with other secondary treatments [13]. For aquatic macrophytes that possess roots but do not have a close physical association with sediments, the water is undoubtedly the principal source of elements. The uptake and subsequent release of trace metals during transmission to organisms of higher trophic levels represents a pathway detailing the cycling of trace metals in aquatic ecosystems [14].

Wendy [15] reported that metals uptake in plants, for many contaminants, passive uptake via micropores in the root cell walls (the apoplastic pathway) may be a major route into the root, where sequestration or degradation can take place. The apoplast is a hydrated free space continuum between the external soil solution and the cell membranes of the root cortex and vascular tissue. The cell wall micropores exist within a network of cellulose, hemicellulose, pectins, and glucoprotein containing many negative charges (generated by carboxylic groups) that act as cation binding sites and exchangers and as anion repellers. Di- and polyvalent cations (the form of many heavy metal and radionuclide contaminants) are preferentially attracted to, and bound on, these cation exchange sites within the root cortex cell walls [16]. Some researchers believe that plants for phytoremediation should accumulate metals only in the roots [17, 18, 19]. Dushenkov [17] explained that the translocation of metals to shoots may decrease the efficiency of rhizofiltration by increasing the amount of contaminated phytomass which will need disposal.

Phytoremediation differs from other pollutant treatment systems, which may have only one specific pollutant removal mechanism, in that several strategies, such as planned periodic harvests or natural dieback of aerial shoot of plant biomass to eliminate the accumulated metals, can be employed [20] . Then when harvest comes after the plants have performed their phytoremediation role, the potential exists for the use of the harvested phytomass for further extraction of metals from the harvested material [21.22].

Typha spp. plays an important role in metal retention by virtue of immobilization of metals in oxygenated rhizosphere. Moreover, roots of macrophytes can accumulate great amount of heavy metals due to its cortex parenchyma with large intercellular air spaces [23].

Typha tolerates enhanced levels of metals in its tissue without serious physiological damage. Dunbabin and Bowmer [24] reported metal concentrations to increase in the following order: roots > rhizomes > non-green leaf > green leaf. They reported that the metal up taking by plants was highest in the roots in contaminated cases, and the green leaves have lowest concentrations in copper (Cu), zinc (Zn), lead (Pb) and cadmium (Cd).

The differences in the uptake rate of metals by aquatic plants could depend on factors such as the plant species and the type of metal, as well as the seasonal growth rate changes and the metal ion being absorbed [25].

Other contaminants

T. latifolia showed a potential for removal of TNT from contaminated water under *invitro* conditions with small differences in the formation of the major degradation products – monoaminodinitrotoluenes [26].

Typha latifolia (UT series) provided high removal of organics from tannery wastewater, up to 88%of biochemical oxygen demand (BOD5) (from an inlet of 420 to 1000 mg/L) and 92% of chemical oxygen demand (COD) (from an inlet of 808 to 2449 mg/L) and of other contaminants, such as nitrogen [27].

Valsera [28] reported that doxycyclin was removed in FW systems planted with *T. angustifolia* (65□35-75□40%) and ampicillin was eliminated by a *T. angustifolia*- floating macrophytes system (64□30%).

Advantages

Typha species have important properties such as a high natural productivity and they have the ability to accumulate large amounts of heavy metals and nutrients [29].

The possibility of *Typha* species utilization to investigate waste–water treatment was done by Junrungreang and Jutvapornvanit at the Land Development Department (Bangkok, Thailand) in 1996. They found *Typha* species could produce large quantities of biomass, the total annual productivity being approximately 56.6 ton/ha. They indicated that the uptake ability of the *Typha* species above ground differed to that of below ground. *Typha* species have a rather high capacity to absorb heavy metals such as copper, manganese and zinc. They detected that the elements accumulated more in broad–leaf *T. latifolia* than narrow–leaved *T. angustifolia*. They also noted that seasonal dynamics affected the concentration of chemical elements and biomass in *Typha* species. They concluded that *Typha* species can be used for water purification and they should be harvested during summer to remove metals from waste–water [29].

Typha species are among the most productive plant species [30, 31, 32] ; however, their performance is strongly influenced by the environment. Cattails are physiologically better able to tolerate permanently flooded conditions than are many other emergent species. Cattail seeds can germinate without oxygen [33], the adult plants are able to maintain high rates of photosynthesis under low soil redox condition [34, 33] and the roots are able to oxygenate their rhizosphere without showing signs of oxygen deficiency [35].

T. Latifolia was exposed to single solutions of Pb (5 mg/L), Cr (0,5mg/L), Mn (7 mg/L) or Fe (7 mg/L) and respectively removed 75, 50, 29 and 81% at pH 6 [36] .

The cattailis every part has uses. It is easy to harvest, very tasty, and highly nutritious. It was a major staple for the American Indians, who found it in such great supply, they didnít need to cultivate it. Reduced algae photosynthesis due to shading by *Typha latifolia.*

Dordio [37] conducted conducted to assess *Typha* spp.'s ability to withstand and remove, from water, the non-steroidal anti-inflammatory drug ibuprofen. For an initial ibuprofen concentration of 20 mg/L, *Typha* removed nearly 60% of it within the first 24 h, attaining over 99% removal by the end of the assay (21 days). Exposure to higher ibuprofen concentrations did affect *Typha's* growth but, by the end of the assays, plants' growth as well as photosynthetic pigments approached normal values. Eventually, *Typha* seemed able to cope with ibuprofen's induced oxidative damage suggesting its ability for phytotreatment of waters contaminated with ibuprofen.

CONCLUSION

The ability of aquatic weeds to absorb and accumulated various metals that they take from the aquatic environment has been demonstrated by a number of research workers [38, 39]. *Typha* can be recommended as a macrophyte species with greater potential for use in phytoremediation of heavy metal

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contamination as shown in table 1. More studies are required to gain a better understand the mechanism involved in uptake and removal of contaminants from wastewaters that can be utilized for phytoremediation technology.

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Table 1:- *Typha* species depicts potential for removing heavy metals.

Plant species	Heavy metals	References
T. angustifolia	Cu, Zn, and Ni	[40b]
T. latifolia	Pb, Cd, Cu, Ni and Zn	[41, 8, 42]
T. dominengensis	Pb, Al, Zn and Fe	[43, 6]
T. orintalis	Cu, Cd, Pb and Zn	[44]
T. capensis	Pb, Cd, Cr, Fe, Mn, Cu, Ni and Zn	[14]

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