Wetland macrophytes in purification of water
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ABSTRACT

Wetland is very much rich in biodiversity and a considerable number of which is macrophytes those are mostly involved in purification of water. In this study two common macrophytes, Pistia stratiotes and Alternanthera philoxeroides, were taken to check their efficiency in purification of polluted water contaminated with toxic substances such as arsenic, cadmium and chromium. From the experimental results it appears that each of the two wetland macrophytes are more or less equally effective in the accumulation of the arsenic, cadmium and chromium from the contaminated water to purify it. Thus, from this study it may be suggested that wetland macrophytes play a vital role to assist the wetlands to act as ‘kidney of Nature’.

Keywords: Wetlands, macrophytes, toxic-substances, accumulation, purify polluted water.

1. Introduction

Nature is an excellent teacher. If we desire we can understand the significances of many of the natural phenomena by paying our attention to make use of it as our own process for the benefit of mankind. Nature can nurture itself by developing different natural processes as the life supporting systems in this planet. Advent of civilization caused rapid, injudicious urbanization and industrialization ignoring the importance of environment. Gradually, the environment has become polluted. Toxic metal pollution is one of the threats to human civilization although human society is discharging maximum of toxic metals into the environment. Increased discharge of toxic metals eventually causes bioaccumulation and biomagnifications (Chaphekar, 1991; Pergent and Pergent-Mardini, 1999; Dembitsky, 2003) and thereby results a bad impact on public health.

Phytoremediation is the purification of polluted environment with the help of plants. Since it is natural process, its benefits are receivable almost free of cost (Ghosh, 2013). Phytoremediation also includes phytoextraction (Kumar et al. 1995), rhizofiltration (Dushenkov et al. 1995), phytostabilization (Salt et al. 1995) and phytotransformation/phytodegradation (Susarla et al. 2002). Phytoaccumulation / phytostabilization of toxic metals by the wetland macrophytes which is one of the natural means to slow down the entry of toxic metals into the food chain (Ghosh, 2013). In this present study two less investigated macrophytes such as water cabbage (Pistia stratiotes L.) and Alligator weed (Alternanthera philoxeroides (Mart.) Griseb) were taken to check their toxic metal accumulation capacity for purifying water. This study is an endeavour to enrich the information regarding the phytoremediation to utilize natural phytoremediation strategies for effective accumulation of toxic metals from the polluted water to resist toxic metals to enter into the food chain in large amount for the benefit of mankind.
2. Material and methods

Two macrophytes were taken as experimental materials and they are *Pistia stratiotes* L. and *Alternanthera philoxeroides* (Mart.) Griseb because these two are less investigated wetland macrophytes. One of the three toxic substances tested here is a metalloid such as arsenic as sodium arsenate (NaH$_2$AsO$_4$.H$_2$O) because arsenic is one of the abundant and notoriously poisonous polluting agents in this subcontinent. The other two toxic metals tested here are two heavy metals viz., cadmium as cadmium chloride (CdCl$_2$.H$_2$O) and chromium as chromium phosphate (CrPO$_4$) since these two transition metals, cadmium and chromium are most prevalent contaminating agents in the urban and semi urban areas of India (Pal and Kundu, 2011).

To make a single set of experiment 50 ml of 25 mg l$^{-1}$ of toxic substance contaminated solution was taken in a suitable pot. Each set of experiments was replicated thrice. To check the accumulation capacity of *Pistia* the contaminated solution was treated with two standard *Pistia* plants for 48 hours. For control set there was no *Pistia* plant to treat the 25 mg l$^{-1}$ of toxic substance contaminated solution. Thus, the experiments were performed in a similar fashion for each of the three toxic substances such as for arsenic, cadmium and chromium. To test the accumulation capacity of *Alternanthera* similar experiment sets were made replacing the *Pistia* plants by two 15 cm twig (from tip) of *Alternanthera* plants. The duration of treatment in this case also was 48 hours. Each set of experiments was replicated thrice. For control set there was no *Alternanthera* plant to treat the 25 mg l$^{-1}$ of toxic substance contaminated solution.

To measure the presence of residual toxic substance, if any, in the solution after 48 hour of treatment with macrophyte, an *in vitro* pollen germination test was performed following the method of Gottardini et al. (2004) and Ghosh (2007). For this test the mature pollen grains from the flower of *Catharanthus roseus* were germinated in the suitable medium to verify the constituents of optimal medium and it was found out that 10% sucrose solution with 100 mg l$^{-1}$ of boric acid was the optimal medium to have optimum rate of germination of pollen (Figure 1).

![Figure 1: Germination of pollen of Catharanthus roseus in different concentrations of sucrose with 100 mg l$^{-1}$ of boric acid.](image-url)
3. Result and conclusion

*In vitro* pollen germination of *Catharanthus roseus* was inhibited significantly in each of the three media containing arsenate, cadmium and chromium (Series 1 of the bar graph in Fig. 2) in respect of control (blue bar graph). The media prepared with toxic substance contaminated water and subsequently treated with *Pistia* plants for 48 hours also inhibited the germination of pollen significantly except in case of chromium contamination where pollen germination was not significantly inhibited (Series-2). However, in each of the above two cases of inhibition of pollen germination it is clear that the inhibition became less in respect of the media containing arsenate and cadmium contaminated water without *Pistia* plant treatment. In other words toxicity with regard to pollen germination was decreased in each case due to treatment with *Pistia* plant.

![Figure 2: Effect of toxic substances on pollen germination of *Catharanthus roseus* before treatment with *Pistia* (Series -1) and after treatment with *Pistia* (Series -2)](chart)

*In vitro* pollen germination of *Catharanthus roseus* was inhibited significantly in each of the three media containing arsenate, cadmium and chromium (Seris 1 of the bar graph in Fig. 3) in respect of control (blue bar graph). The media containing rest of the toxic substance contaminated water after treatment with *Alternanthera* also inhibited pollen germination (bar graph of series-2 in the figure) but the inhibition was much less in comparison with contaminated untreated water containing media.

From the results (Fig.2) it appears that *Pistia stratiotes* can accumulate water-dissolved toxic substances viz., arsenate, cadmium and chromium to purify the contaminated water. But the accumulation of arsenate and cadmium was less than that of chromium. Prajapati et al. (2012) concluded that aquatic macrophytes *Pistia stratiotes* can be used for phytoremediation of water bodies polluted with toxic metals Cr and Co in a sustainable way. Ghosh (2013) reported that *Pistia stratiotes* was most effective in accumulating arsenic when it was used as Sodium arsenite. Thilakar et al. (2012) showed that though *Pistia stratiotes* L. and *Salvina natans* (L.) All. are invasive plants, they can effectively be employed in the phytoremediation of aquatic ecosystem which have been polluted by harmful, toxic heavy metals like Chromium and Copper. These reports and the observed results in this study help us to claim
that *Pistia stratiotes* L. is an effective accumulator to purify the water contaminated with arsenic, cadmium and chromium.

![Figure 3: Effect of toxic substances on pollen germination of C. roseus before treatment with *Alternanthera* (Series -1) and after treatment with *Alternanthera* (Series -2)](image)

*Alternanthera philoxeroides* is more or less equally effective in accumulation of each of the three toxic substances those are arsenic, cadmium and chromium. Pal and Kundu (2011) reported that *Alternanthera philoxeroides* has the potential for phytoremediation of multiple contaminated sites including the soil contaminated with cadmium and chromium. Hu Nan et al. (2013) demonstrated that *Alternanthera philoxeroides* might be a potential native plant species for phytoremediation of the contaminated soil, sediment, and river water by the target metals like zinc and cadmium within the basin. Tripathi et al. (2012) demonstrated that *Alternanthera ficoidea*, one of the terrestrial species, has maximum specific arsenic uptake capacity. Thus, from the present study as well as from the earlier reports it may be suggested that *Alternanthera* is an effective plant to depollute the arsenic, cadmium and chromium contaminated water.

Phytoextraction, rhizofiltration, phytostabilization, phytoaccumulation, phytomining, phytotransformation, phytodegradation, phytovolatilization etc are the different means under phytoremediation in which wetland macrophytes play a vital role. These are all natural processes and involved in cleaning up mother earth to reduce or slow down the entry of toxic substances into the food chain (Ghosh, 2013). Thus, ‘nature can nurture’ itself to act as the life supporting system and wetlands justify its name ‘kidney of Nature’ with the help of different aqua floras and faunas involving wetland macrophytes including *Pistia stratiotes* and *Alternanthera philoxeroides* as shown in this study.
4. References


