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REDUCTION IN CHROMIUM CONTENT OF TANNERY EFFLUENTS BY USING SOME SELECTED HYDROPHYTES

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ABSTRACT

Treatment of tannery effluents with hydrophytes viz., *Chara intermedia, Typha angustifolia, Hemarthria compressa, Pistia stratiotes, Marsilea minuta* and *Salvinia natans* showed a reduction in the heavy metal component of the effluents after growing them in tannery effluents. *Typha angustifolia* was found to be the best followed by *H. compressa.* These plants not only tolerated the full concentrations of tannery effluents but also reduced chromium content of the effluents upto a considerable extent. Other species exhibited more sensitivity towards high concentrations of the effluents and could not survive long during the experiment.

Key-words: Chromium, tannery effluents, hydrophytes

INTRODUCTION

Heavy metal pollution of water and soil is a burning issue of the present world. The fast growing urbanization, industrialization and other developmental activities have brought a variable water crisis in Pakistan and accelerated the fluxes of metallic species and other toxic organic and inorganic substances in water and soil sources. Tannery is the second most dynamic sector after textile, producing a large amount of waste byproduct (effluents) with toxic constituents especially the heavy metal, chromium.

Leather industries (tanneries) are a major source of pollution in Pakistan (Khan 2001). In Pakistan, tanneries concentrate in Korangi (near Karachi), Kasur, Muridke, Sialkot, Multan and Gujranwala.

During the tanning process, a number of chemicals are used, surplus of which are released as effluents (Smith, 1971). Chemical analyses of these effluents reveal that they have high organic and inorganic pollution load. Among the chemicals used during this process, chromium being a heavy metal is a controversial element on account of its persistence and potential toxicity. Several physico-chemical methods, for clean up of polluted water and soils are currently being used such as precipitation, oxidation/reduction, ion exchange, filtration and evaporation, but theses methods are extremely expensive, lack specificity and require extreme caution in toxic sludge disposal. A research for low cost and easily available technology is strongly needed like Phytoremediation, a new and improved "clean" technology, providing solution to water and soil pollution by growing tolerant plants.. Accumulation and uptake of heavy metals in the plant depends on the plant species, the element its bioavailiability, redox, pH, cation exchange capacity, dissolved oxygen, temperature and secretion of roots.

Plants are employed in the decontamination of heavy metals from polluted water and have demonstrated high performances in treating mineral tailing water and industrial effluents (Cheng, 2003).

Brooks *et al.*, (1977) suggested that plants capable of accumulating more than 100 times larger concentration of metals than normal plants may be termed hyperaccumulators.

The present study was employed to reduce the heavy metal chromium of tannery effluents by using "Green Clean" technology and to screen out hyperaccumulating hydrophytes. It was desired to make an assessment of tannery effluents from irrigation point of view and to study the tolerance of selected hydrophytes for different concentrations of tannery effluents.

MATERIALS AND METHODS

Pretreated tannery effluents were collected from the large lagoons, constructed by Kasur Tanneries Waste Management Agency (KTWMA), Kasur, where these effluents are being collected for every three months. Effluents were collected in cans and transported to the laboratory. They were mixed in a huge container and dilutions 0%(C), 25%(E1), 50%(E2), 75%(E3) and 100%(E4) were prepared for different experimental treatments by homogenously mixing the effluents with irrigation water.

Hydrophytes viz., *Typha angustifolia* Bory and Chaub, *Hemarthria compressa* (L.F). R. Br., *Pistia stratiotes* L., *Marsilea minuta* L. and *Chara intermedia* Braun, were collected from uncontaminated large ponds located along G.T. Road near Muridke. *Salvinia natans* (L). All. was collected from the Botanical Garden of the Punjab University.

The experiment was laid out in the wire house, in plastic pots (four-liter capacity in a "Completely Randomized Design" with factorial arrangement (Steel and Torrie, 1981). Plants were grown in different concentrations of effluents in triplicates. In case of plants of *T. angustifolia*, each plant was tied to a string, which was connected to the roof of wire house for the purpose of erection of stems. Chromium content of the effluent samples was analyzed before the treatment with plants (A0) and after first (A1), second (A2) and third month of treatment (A3).

Chromium (Cr) was determined by aspirating directly the sample solutions into nitrous oxide-acetylene flame. The determinations were carried out on Atomic Absorption Spectrophotometer (Varian AA-1275 series). Metal contents were calculated by comparison with standards treated with the same amounts of reagents as for the sample.

RESULTS

After treatment with different concentrations of tannery effluents the following observations were recorded in these hydrophytes.

Chara intermedia:

This plant was grown in different concentrations of tannery effluents but it survived only for a few days and gradually decayed in all of the treatments within twenty days. So chemical analysis of this plant was excluded from study because of incomplete treatment.

Typha angustifolia:

It was found to be a successful tolerant plant for different concentrations of tannery effluents. In the beginning, during the first month, it showed some wilting and withering but afterwards it flourished well and developed new leaves. It survived until the end of the experiment, for three months.

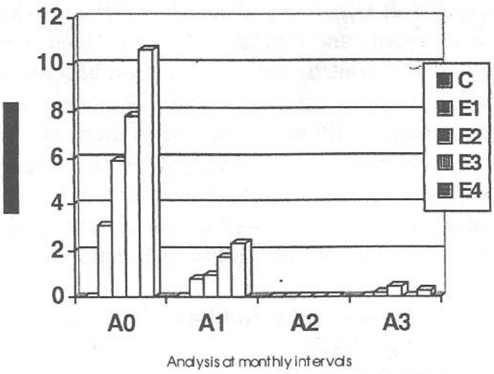

Fig.1. Change in Cr content (ppm).

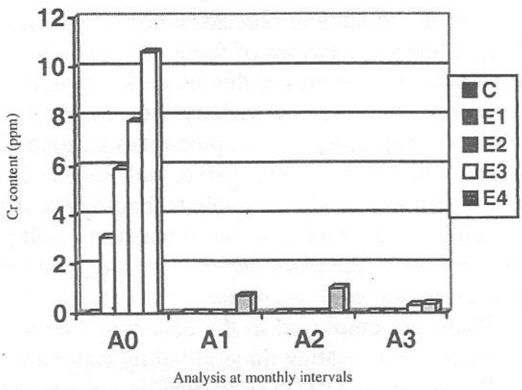

Fig. 2. Change in Cr content (ppm).

Chromium content of tannery effluents after treatment was reduced significantly showing the ability of this plant to accumulate the metal up to a considerable extent (**Fig.1**).

Hemarthria compressa:

After introduction to the different concentrations of tannery effluents, *Hemarthria* showed good tolerance in all treatments and exhibited good growth and development up to the three months of experiment.

The chromium content was reduced in different treatments of tannery effluents. This decrease was quite evident even after one month due to uptake of chromium by the plant (**Fig.2**).

Marsilea minuta:

This plant survived in different concentrations of tannery effluents only for a month. Rate of decay of plants in higher concentrations i.e, in E_3 and E_4 was high as compared to lower concentrations of tannery effluents. But before the end of second month all the plants decayed completely except the control.

Data pertaining to the chromium content of effluents after treatment with *Marsilea* is recorded in the Fig. 3. Although plants survived only for a month but they reduced the chromium content of the effluents during that period. The reduction was more prominent in lower concentrations as compared to the 100% effluents (E4) (**Fig.4**).

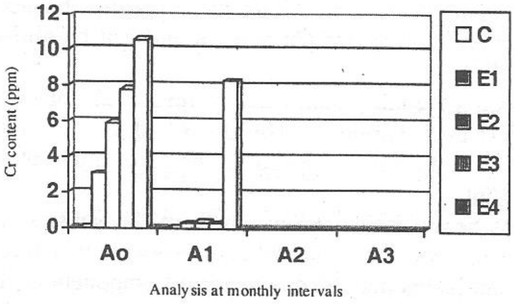

Fig. 3. Change in Cr content (ppm).

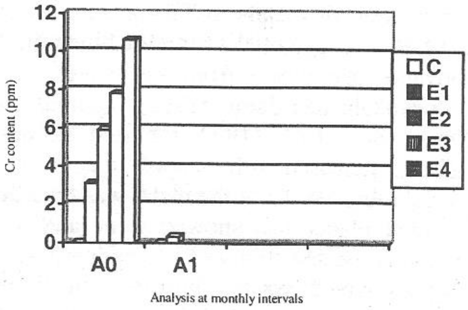

Fig.4. Changes in Cr content (ppm).

This plant decayed in all the concentrations except the E1 and the control. Change in the chromium content of tannery effluents after treatment can be visualized in the **Fig. 4**.

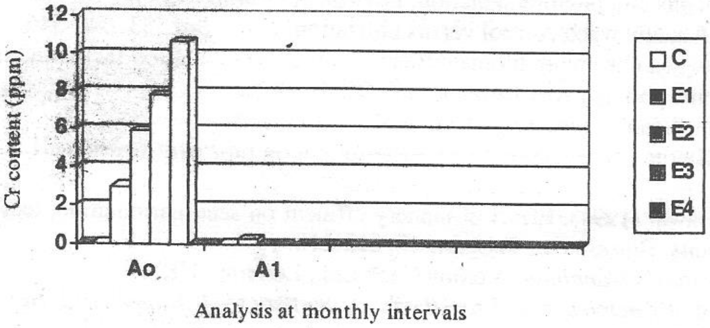

Fig. 5. Changes in Cr content.

Plants survived only in the E1 treatment and reduced the chromium content of the effluents up to a significant extent. Accumulation of metal was more in roots than in leaves.

Salvinia natans

This plant survived only in the control and E_1 treatment for one month. In all the other treatments death and decay of plant occurred.

A decrease in the Cr content was observed in the E1 treatment where plants survived for one month (**Fig. 5**).

DISCUSSION

The use of green plants for recovering heavy metals from industrial effluents is a biotechnology meant to recycle such kind of waste water to river water. According to the Taylar and Crowder (1984) *Typha* has an internal mechanism of metal tolerance like Cu, Ni, Pb, and Zn. *Typha latiofolia* has been employed in secondary wastewater treatment schemes (Gopal and Sharma, 1980).

Kim (1996) reported that tall fescue, clover and rye grass, have been particularly effective in the remediation of contaminated soils. However, *Typha* can be preferred over *Hemarthria* because it can produce more biomass.

Results regarding the chromium content of the effluents after treatment with different hydrophytes revealed that *T. angustifolia* and *H. compressa* were the best among the six selected plants, which not only tolerated full concentrations of the effluents but also reduced the chromium content up to a considerable extent.

Barman *et al.*, (2001) reported the assessment of industrial water of an electronic component manufacturing unit with electroplating and its subsequent effects on soil and plants receiving the effluent. He reported that an elevated accumulation of metals in *Eichhornia crassipes* and *Marsilea* sp. growing along the effluents channel has been identified as a potential source of biomonitoring of metals particularly for Cu and Ca and can be utilized for the removal of heavy metal from wastewater.

Satyakala and Jamil (1997) reported that *P. stratioties* L. could absorb heavy metals at concentrations of 100ppm. Sen *et al.*, (1994) reported the uptake of Cr (VI) in *S. natans* L. The uptake of Cr (VI) by the plant gradually increased with increase in concentration of Cr (VI) in the culture medium. They found that the maximum removal (about 90%) of the metal was recorded below 5 μg/ml.

Other plants also showed some ability to accumulate heavy metal chromium from the substratum, but the problem is the sensitivity of the hydrophytes towards the concentration of the tannery effluents which represents a very toxic type of waste. Thus, this sensitivity of non-tolerant plants may be due to some component of the effluent or overall strength of salts. Therefore while applying the phytoremediation technology, care should be taken both in the selection of plants as well as the remediation site.

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