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Search for Phytoremediating Plants in a Textile Dye Polluted Area of Dhaka City, Bangladesh

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ABSTRACT

Phytoremediation is a powerful yet affordable tool for clean-up of various contaminated sites through use of plants. Many plants exist that can not only survive in polluted areas but also hyperaccumulate industrial and domestic pollutants, which can range from heavy metals to oil and grease. Bangladesh is noted for its garment industries, but suffers from the problem of having areas, which are contaminated with textile dye wastes. Such an area exists in Savar of Dhaka city, the capital of Bangladesh. A survey was carried out in the area to search for plants growing within the textile dye-contaminated site with the further objective of determining the phytoremediation capacity of the plants through available database searches. Our survey found 15 plants distributed into 10 families to be growing in the contaminated area. Literature search showed that nearly all the plants have reported phytoremediation capacities, and as such can possibly provide an easy and affordable way to clean up textile dye-contaminated sites.

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INTRODUCTION

Phytoremediation refers to the technology where plants can be used to reduce, remove, degrade or immobilize environmental pollutants, which can arise from both domestic as well as industrial wastes. Such pollutants can be heavy metals, toxins, textile dyes, pesticides, or even household food wastes. The best things about phytoremediation are its effectiveness and cost-affordability.Pollutants can accumulate in large bodies of soil or water or both and it can be beyond human means or would necessitate exorbitant costs to clean up such soil and water bodies.

A number of plants have been described that can hyperaccumulate and so remove heavy metals from soils. A few examples of such plants are *Thlaspi caerulescens* for removal of zinc and cadmium, *Berkheya coddii* for removal of nickel, *Asparagus racemosus* for removal of selenium, *Iberis intermedia* for removal of thallium, *Ipomoea alpina* for removal of copper, *Haumanistrum robertii* for removal of cobalt and *Pteris vitata* for removal of arsenic [1]. Cleaning of polychlorinated biphenyl (PCB)-contaminated garden soil by phytoremediation has been described [8]. Phytoremediation of crude-oil contaminated soil with the plant *Glycine max* has been described [10]. Phytoremediation of pesticide-contaminated soil and water has been reported [7].

Effluents from textile industries can contain many contaminating substances, which can potentially pollute the soil and water of the surrounding environment. These substances include dyes, nitrate, oil, grease, aluminum, manganese, iron, zinc and copper [21]. The bioremediation of textile wastes using the fungus *Phanerochaete chrysosporium* has been described [3]. Phytoremediation of textile effluents and mixture of structurally different dyes by the plant *Glandularia pulchella* has been reported [6]. Phytoremedition of synthetic textile dyes by *Eichhornia* sp., *Salvinia* sp., and *Pistia* sp. has been shown Anjana and Thanga, [2].

Instead of a blind serach for phytoremediating plants to clean up polluted areas, a better method is to look for plants growing within the contaminated area and analyze their growth and hyperaccumulating capacities. Their very survival and growth in polluted areas suggest that either the plants have grown resistant to the

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pollutants or are accumulating pollutants with non-negative results on growth and survival. If the latter is the case, then these plants can prove to be good sources for clean-up of toxic areas at affordable costs.

Bangladesh is known for its garment industries. However, these industries are also a source for chemical contamination of surrounding soil and water. Savar is on the outskirt of Dhaka, the capital city of Bangladesh and has a number of textile manufacturing units. A preliminary survey resulted in the finding that the surrounding areas of a few such units are heavily contaminated with textile dye effluents as manifested by changes in soil and water color. However, a few species of plants were found to be growing amidst the contaminated areas. The objective of the present survey was to collect and identify the plants and survey the available scientific literature for any phytoremediation properties described for those plant species. Any such description can lead to further studies on the hyperaccumulating or phytoremediating properties of these plant species and open up an affordable means to clean up the contaminated areas.

MATERIALS AND METHODS

A preliminary survey was carried out among the textile units of Savar and their surrounding areas, and from this survey one such site was found where the surrounding soil and water of about half a mile radius of the unit were contaminated with textile dye effluents coming out of the unit. The water was multi-colored, while the soil had different colorations in different places. The site was chosen and all plant species found to be growing in the contaminated soil and water were collected, photographed, and brought to Bangladesh National Herbarium for complete identification.

RESULTS AND DISCUSSION

A total of 15 species of plants distributed into 10 families were observed to be growing on the contaminated areas. The results are shown in Table 1. The Asteraceae and Euphorbiaceae families contributed three species each and may prove to be the ideal species for cleaning up textile dye contaminated soil and water bodies. A perusal of the scientific literature showed that most of the species have reported phytoremediation properties.

Table 1: Plants observed to be growing in a textile dye contaminated site in Savar, Dhaka, Bangladesh.

Serial Number	Botanical name	Family	Local name
1	*Alternanthera philoxeroides* (Mart.) Griseb.	Amaranthaceae	Haicha
2	*Blumea lacera* (Burm.f.) DC.	Asteraceae	Kukur shuka
3	*Spilanthes acmella* (L.) Murray	Asteraceae	Nak ful
4	*Xanthium strumarium* L.	Asteraceae	Hagra
5	*Basella alba* L.	Basellaceae	Puin shak
6	*Ipomoea aquatica* Forssk.	Convolvulaceae	Kolmi
7	*Ipomoea fistulosa* Mart. Ex Choisy	Convolvulaceae	Dhol kolmi
8	*Lagenaria siceraria* (Molina) Standl.	Cucurbitaceae	Lau shak
9	*Cyperus rotundus* L.	Cyperaceae	Ghash
10	*Croton bonplandianum* Bail	Euphorbiaceae	Bon morich
11	*Phyllanthus niruri* L.	Euphorbiaceae	Bhui amla
12	*Phyllanthus reticulatus* Poir.	Euphorbiaceae	Chitki
13	*Dolichos lablab* L.	Fabaceae	Shim gach
14	*Ficus benghalensis* L.	Moraceae	Bot
15	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	Khude pana

Alternanthera philoxeroides has been reported to clean up lead and mercury from soils [4,12]. *Blumea lacera* has been reported to hyperaccumulate manganese and zinc from soil of metal-contaminated mining sites [15]. *Croton bonplandianum* has been reported to be a hyperaccumulator of cadmium and lead [11]. *Cyperus rotundus* has been shown to have excellent phytoremediation potential for cleaning up diesel-contaminated wetlands [18]. *Dolichos lablab* has also been reported to accumulate heavy metals from fly ash-contaminated area [16].

Eichhornia crassipes has been shown to phytoremediate zinc, cadmium, copper and chrome from industrial wastewater [20]. A study has shown that *Ficus benghalensis* leaves can remove 96% of hexavalent chromium from wastewater [13]. *Ipomoea aquatica* has been reported to phytoremediate metal-polluted soils [5]. *Ipomoea fistulosa* has been found to be growing in heavy metal-polluted soils [19], and as such deserves further studies for its phytoremediation potential. *Lagenaria siceraria* can also degrade crude oil when grown on crude oil polluted soil supplemented with wood ash [17]. *Phyllanthus reticulatus* has some capacity for phytoremediating chromium [14]. *Xanthium strumarium* has also some capacity for phytoremediating heavy metals [9].

Most of the plant species found in the polluted area of the present study has reported phytoremediating capacities, if not for textile dyes, then for heavy metals. It would be of interest to study the phytoremediating capacities of these plants for textile dyes and other effluents from garment industries. Such studies can pave the way for easy and affordable removal of textile industries' pollutants.

Fig. 1: *Croton bonplandianum*.

Fig. 2: *Cyperus rotundus*.

Fig. 3: *Ipomoea aquatica*.

Fig. 4: *Lagenaria siceraria*.

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