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# Accumulation of Chromium in Certain plant Species Growing on Mine Dump from Byrapur, Karnataka, India

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## Abstract

*In Byrapur Chromite mining area of Hassan District, the plant species, such as Hyptis suaveolenes and Cassia siamea have been growing in chromite mine tailing dumps. The chromium content in the dump soil and in the leaves and stems of the sampled plants was determined and compared with samples collected from non-mineralized zone. Generally the chromium content in the plants growing on the dumps was higher than the samples from non-mineralized zone. Accumulation of chromium in the plant species and in their organs varies e.g. the Cr content is higher in leaves than in stems. In the non-mineralized zone, the chromium content was high in Cassia siamea whereas higher accumulation and distribution of chromium is observed in Hyptis suaveolens from the mining dump site. The study reveals that the mechanism of Chromium tolerance involved in Cassia siamea is possibly different from that of Hyptis suaveolens. The plants can ideally be used as the possible application in agricultural reconnaissance surveys, reclamation and revegetation of adversely affected mining environment and also for phytoremediation.*

**Keywords**: Hyptis suaveolens, cassia siamea, mine dump, chromium, soil, Byrapur, Karnataka.

## Introduction

Many important factors in the natural development of plants arise either directly or indirectly from their geological and geochemical environment. Phytoremediation is an environmental clean up strategy in which selected plants are employed to remove the environmentally toxic contaminants. This is an ideal and important emerging biotechnological application and operates on the principle of biogeochemical cycling[1]. The possible use of vegetation for determining the chemical properties of the substrate on which the vegetation grows has been a matter of great interest in searching for substrate waters and evaluating soil quality. In recent years, geologists have emphasized the value of chemical composition of plant material as an exploratory tool[2,3]. Human beings have increased the trace element content of their environment while exploiting mineral reserves. In such areas, mine dumps or tailings causes a major problem. They contain concentrations of heavy metals that are toxic to plants and animals. Reclamation of mining impacted lands can restore fertility and aesthetic value to these lands and increase areas of wildlife habitat and livestock use. The plants species which have the ability to successfully germinate grow, and reproduce under the adversely affected environments have to be useful for reclamation and revegetation. Generally most of the plant species which grow in mineralized areas are known to accumulate metals, relatively in excess proportion than in non mineralized areas.

In the Byrapur chromite mining area, the predominantly occurring plants on the chromite mine dump include *Hyptis Suaveolens* and *Cassia Siamea*. The aim of the present study is to generate the information on chromium accumulation and distribution pattern in some of the plant species that naturally colonized in Cr mine tailings/dumps and compare it with the samples from non-mineralized zone.

**Area of the Study:** Byrapur (13 06' 20" - 13 06' 56"; 76 24' 30" - 76 20' 40" ; Toposheet No. 57 C/8) is located in Hassan District, Karnataka (Fig. 1) The average annual rain fall is about 900 mm and most of this rain fall receives during the northeast monsoon period.

Byrapur chromite mineralized zone comes under Nuggihalli schist belt, one of the ultramafics rich belts in the Dharwar craton[4]. Sporadic occurrence of sulphide mineralization has also been known from this belt[5]. The chromite ore around Byrapur is associated with a linear and narrow band of metamorphic basic and ultrabasic rocks and occur as lensoid bodies. The ore bodies are the result of magmatic segregation. The geological formations in Byrapur mineralized belt are tremolite schist, dunite peridotite amphibolite, and serpentinite talc. Earlier workers studied the oxidation character of chlorite[6], and chemical studies of chromo chlorite of Byrapur chromite area[7,8].

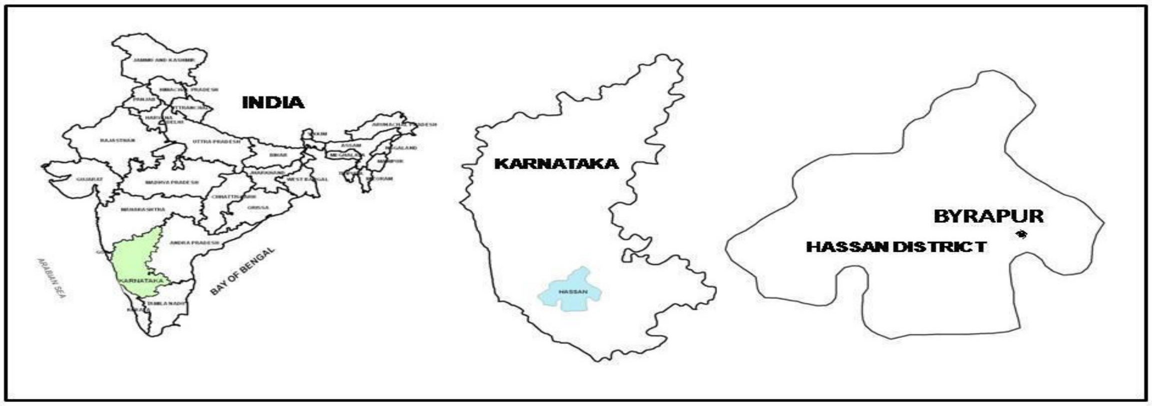


**Figure-1**
**Location Map of the Study area**

## Material and Methods

Composite samples of the leaves and stems of the eight plants per species (*Hyptis suaveolens* and *Cassia siamea*) and soil were collected from the mine dumps. Similarly, the leaves and stems samples were collected from the same plant species growing on non-mineralized zone together with soil samples to determine the plant-soil relationship and also to study the indicator characteristics of the plants. Leaves and stems were collected separately at various points around the circumference of the tree and these are made into a composite sample. Care was exercised to collect matured plant materials that have gone through the main process of mineral accumulation. The sample preparation of the plant material for the laboratory study was made as suggested by Brooks[9]. Plants samples were washed thoroughly with distilled water to remove soil or dust contamination and air dried. The moisture was eliminated by keeping these samples in a hot air oven at 110$^o$C. The oven dried material was ignited into ash in a muffle furnace at 500$^o$C for six hours, and digested in 2M HCl. Samples of soils were oven dried at 110$^o$C, and lightly disintegrated in a porcelain mortar. Finally, 2mm sieved samples were powdered and ignited at 500$^o$C in a muffle furnace for six hours and then digested in aqua regia .All samples were analyzed for Cr content by atomic absorption spectrophotometry.

## Results and Discussion

The Cr content in the plants growing on dumps is generally higher than the same plant species growing on non-mineralized zone (table 1). Similarly the Cr content in leaves and stem samples collected from the dump area is higher than that of the samples from non-mineralized zone. This clearly reveals that accumulation of Cr was higher in the plants developed on the dump. Even though these two plant species are growing in the mining area under the same environment, Cr content in their organs are varied. Hence the mechanism of Cr uptake may be different in these plants. Cr content was significantly higher in leaves than in stems in both the mining dumps and in non-mineralized zone. This indicates that irrespective of location of the tree, the Cr content is higher in leaves than in stems. The distribution of Cr in leaves, stems, and soil on mine dump and non-mineralized zone is diagrammatically shown (figure 2).

The Cr content is high in the leaves and stems of *Hyptis suaveolens* than the *Cassia siamea.* In *Hyptis suaveolens* , the ratio of Cr content in leaf samples of non-mineralized zone and mine tailings is about 1 : 9.55, where as it is about 1: 11 in stems. Similarly in *Cassia siamea* the ratio of Cr content in leaf samples of non-mineralized zone and mine dumps is about 1:3.5, where as it is 1:4.08 in stems. Hence it reveals that under Cr stress condition the uptake of the Cr by *Hyptis suaveolens* is high. Therefore there is a need to know about the optimum capacity of the *Hyptis suaveolens* to uptake and accumulate the Cr from the further studies. The ratio of the Cr content between the non-mineralized zone soil and mine dump site soil collected around the *Hyptis suaveolens* was 1:16.61, where as it is 1:33 for the soils collected around the *Cassia Siamea*.

The uptake of Cr by *Cassia siamea* collected in the mine dump is also high than the same plants collected in the non-mineralized zone, but it is not as high as in *Hyptis suaveolens.* On the other hand the ratio of Cr content between soils collected around the *Cassia siamea* of the non-mineralized zone and mine dump site is 1:33. Whereas the ratio between the non-mineralized and dump site samples of leaves of *Cassia siamea* is 1:3.5 and for stems it is 1:4.08. Hence the amount of Cr accumulated in the leaves and stems of *Cassia siamea* may be the optimum for this plant. This reveals that the mechanism of Cr tolerance involved in the *Cassia siamea* is possibly different from that of the *Hyptis suaveolens.*

The distribution of elemental concentrations and the metal uptake in different organs of plant varies widely due to complex process of metabolism. Each plant species has its own requirements and tolerance to elemental uptake and retention. Thus the composition of an individual plant varies substantially among its various tissues types, i.e. roots, wood, bark, twigs, needles-leaves and flowers [10]. Generally the plants take up metals to varying degree from the substrates in which they are rooted and developed[11], and the level of tolerance developed can often be related to the amount of metal in the soil[12].

In both the areas under study, the Cr uptake was high in *Hyptis suaveolens* than that of *Cassia siamea*. The evaluation of plant metal concentrations can be used to obtain information about specific plant behavior in the soil environment and reveals the metal distribution and their mobility. Metal concentration in plants is a function of not only the total soil concentrations but also depends on the chemical speciation of metals in soil and soil solutions[13]and the involvement of metal in biological functions[14]. The plant uptake mechanism normally restricts the nonessential element concentration to a constant level in spite of the higher metal abundance of such metals in the soil[15].

## Conclusion

From this study it may be concluded that the *Hyptis suaveolens* has a kind of special ability to accumulate higher amounts of Cr and it may be under stress condition. But there is a need for further studies to get extra information on its optimum ability to accumulate the Cr content. And the accumulation of Cr content in the leaves and stem of *Cassia siamea* may be the optimum in the study area. Further it may be concluded that accumulation of Cr in these trees in the study area is varied and also it varies in different organs (leaves and stems) of these plants. This may be due to differences in the mechanisms of uptake of this metal. However detailed studies are required to determine the mechanism of Cr tolerance in these sampled plant species. The different plant organs show wide variations in respect of accumulation of different elements[16]. Many workers have studied accumulation of elements in plants and reported various plant species as accumulators of heavy metals[9,17]. Prasad and Vijayasaradhi[18] found *O. adscendens* as an accumulator for Cr, and *Azadirachta indica* was proved as an accumulator of Sr[19]. In plant biogeochemistry, the organ of the plant species selected for analysis is very crucial. Due to complex process of metabolism, the distribution of elemental concentrations in different organs of a plant varies widely. The high concentration of an element in one particular organ does not imply that this is the best part of the plant to sample for biogeochemical prospecting [9]. In this study, it may reveals that these plants may makes suitable for restoration of Cr contaminated areas as these are the ability to flourish on chromium rich dumpsites . Based on these investigations, plants can be ideally used as possible application in reclamation and revegetation of adversely affected mining environments, biological monitoring of the state of pollution of the environment, explore the possibility of recognizing the local plant communities as indicator plants and for phytoremediation.

**Table -1**
**Distribution of Chromium (in ppm) in Leaf, Stem and Soil**

| Name of the Plant | Leaf on Non-mineralized zone | Leaf on Dump | Ratio of Cr content between Non-mineralized and Dump (For Leaf) | Stem on Non-mineralized zone | Stem on Dump | Ratio of Cr content between Non-mineralized and Dump (For Stem) | Soil on Non-mineralized zone | Soil on Dump | Ratio of Cr content between Non-mineralized and Dump (For Soil) |
|---|---|---|---|---|---|---|---|---|---|
| Hyptis suaveolens | 205 | 1958 | 1:9.55 | 134 | 1475 | 1.11 | 90 | 1495 | 1:16.61 |
| Cassia siamea | 350 | 1225 | 1:3.5 | 195 | 796 | 1:4.08 | 28 | 924 | 1:33 |

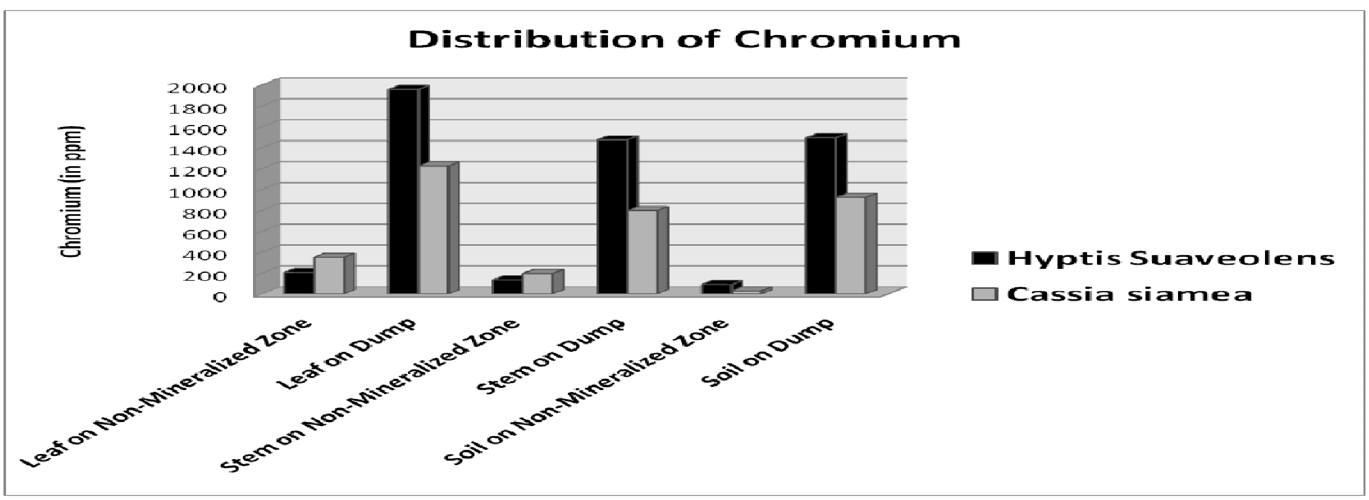


**Figure-2**
**Histogram showing the distribution of Cr (in ppm) in leaf stem and soil on Chromium dump and non-mineralized zone**

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