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ANTIOXIDANT PROPERTY OF *Solanum nigrum* AGAINST HEAVY METAL CHROMIUM

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ABSTRACT

In environment there are varied form of life. Depending on its physical, chemical and biological properties, heavy metals have been released into the environment may move within an aquifer in the same manner that ground water contaminants. The contamination of nature compartments by heavy metals has become a serious environmental problem. Due to high cost of conventional cleanup technology, there is an increasing interest in the remediation of contaminated sites using biological environmental friendly technique i.e. phytoremediation. It this technique in which soil contamination due to industrial activities is minimized. In this method heavy metals are isolated and detoxify. Phytoremediation process is widely accepted as a cost effective and environmental friendly cleanup technology. During the exposure of plants to contaminated soils the antioxidant defense system helps the plant to protect itself from the damage. Antioxidants are substances used the body to protect itself from damage caused by oxidation due to toxic environment. *Solanum nigrum* (Black night shade) is common plant grown in all part of the India. In the presence work the plant *S. nigrum* was exposed to the heavy metal chromium contaminated soils and the biological factors, vitamins and mineral factor and antioxidant factors were investigated. From the observation it is evident that the heavy metal chromium affects significantly the biochemical factors, vitamins and mineral factors and antioxidant factors in *S. nigrum* plant. It is also clear that *Solanum nigrum* is found to be heavy higher antioxidant property than other plants.

KEYWORDS: *Solanum nigrum*, Phytoremediation, Antioxidant Factors

Industrial development and urbanization have resulted several environmental problems in India. Organic and inorganic pollutants including coloured substances, heavy metals, sewage, fertilizers and pesticides increase concentration heavy metal including chromium in soil (Angelone and Bini, 1992). The presence of these contaminants changes physical, chemical and biological status of soil. Some medicinal plants such as *Solanum nigrum*, *Helianthus annus, Annula racemosa Solanum xanthcorpum* etc. minimise the concentration of these pollutants and enhance biological property of soil (Bergmann and Rennenberg, 1993). The black nightshades (*Solanum nigrum* L. and related species) are worldwide weeds of arable land, gardens, rubbish tips, soils rich in nitrogen, in moderately light and' warm situations which occur from sea to mountane levels. They are, however, also widely used as leafy herbs and vegetables, as a source of fruit and for various medicinal purposes.

Solanum nigrum was exposed to the metal Chromium contaminated soils and the biochemical factors, vitamins and minerals factors and antioxidant factors were tested. The present efficiency of soil indicate removal of heavy metals with chromium and show antioxidant property (Berti and Cunningham, 2000) (Blaylock and Huang, 2000).

MATERIALS AND METHODS

Preparation of Polluted Soil

Top soil upto 15 cms depth, was collected from the fertile agriclutrual lands of Bhualpur village near Chunar Mirzapur (U.P.). The samples were air dried, crushed to powder and sieved in 0.5mm mesh. The sieved soil samples were stored in polythene bags.

Different concentrations of Sodium dichromate were mixed with 600 gms of the soil samples and the samplings of the *Solanum nigrum* plants was planted to different pots. The toxicity of the cadmium metal on the both the plants was investigated after a time period of three weeks.

The sublethal concentration and half of sublethal concentration of the Sodium dichromate solution were selected for the toxicity studies of the chromium on the *Solanum nigrum* plants. The plants were exposed to the above metal contaminated soils for four weeks and the biochemical factors, vitamins and minerals factors and antioxidant factors were tested as per standard methods. Carbohydrates, protein, amino acids, fatty acids, DPPH were analyse by following methods:

1. Determination of total carbohydrates by Anthrone method
2. Protein estimation by Lowry's method (Blois, 1958)

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3. Estimation of protein, total free amino acids, proline, reduced glutathione, superoxide dismutase and catalase are done by colorimetric method
4. Estimation of free fatty acids (Titration)
5. DPPH free radical scavenging activity (Blois method) (Chaoui *et al.*, 1997)

RESULTS AND DISCUSSION

In the present research work an attempt has been made to study the effect of Chromium metal polluted soils on the various antioxidant factors, vitamins and minerals factors and biochemical properties of the plants *Solanum nigrum*. In table 1 presents the Biochemical factors of the plant *Solanum nigrum* grown in fertile garden soil, sublethal and half of sublethal Chromium polluted soil (Clemens *et al.*, 2002). The total carbohydrates, total proteins, fats, chlorophyll, Total amino acid and the amino acid except proline were considerably reduced in the plants sample of *Solanum nigrum* exposed to heavy metal Chromium contaminated soil (Cobbett, 2000).

Table 1: Biochemical Factors of the plant *Solanum nigrum*

Factors	Solanum nigrum		
	Control	Sublethal Cr	Half of sublethal Cr
CHO g/100g	7.5	5.2	6.9
Protein g/100g	7.6	5.41	6.50
Fat g/100g	0.8	0.70	0.75
Chlorophyll µg/100g	20.8	15.4	17.1
Total amino acid g/100g	4.2	3.34	3.52
Proline g/100g	4.7	6.12	4.15

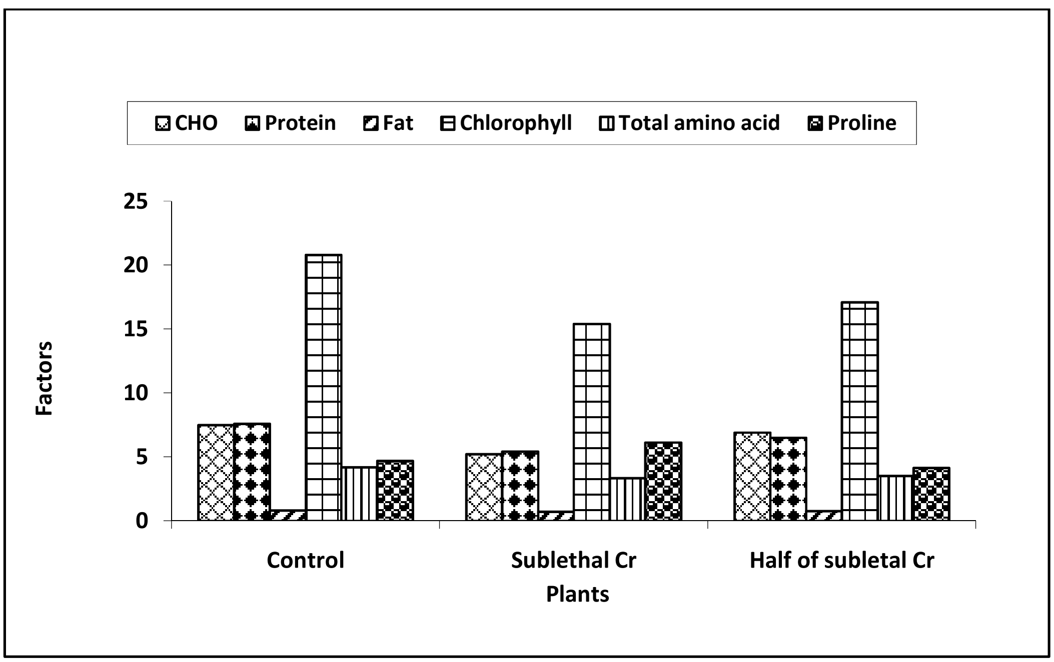

Figure 1: Biochemical factors of the plant *Solonum nigrum*

This may be because proline a non essential amino acid is synthesized in the living organism whenever it is subjected to stress such as high or low temperatures, high salinity, sodicity, high heavy metal exposures etc. Proline accumulation is a common metabolic response of higher plants to water deficits, and salinity stress, and has been the subject of numerous reviews over the last 20 years (Gerard *et al.*, 2000). Proline protects membranes and proteins against the adverse effects of high concentrations of inorganic ions and temperature extremes. Proline may also function as a protein-compatible hydrotrope and as hydroxyl radical scavenger (Godbold and Hittermann, 1985). Proline is organic amino acid, that is used in the biosynthesis of proteins and contain α–amino amino group.

Table 2 shows the vitamin and mineral content of the plants *Solanum nigrum* grown in fertile garden soil, sublethal and half of sublethal Chromium polluted soil. The factors were reduced significantly in the heavy metal contaminated soil (Kramer and Chardonnens, 2001). The vitamins A, B and C and total phenolics and other minerals were significantly high in the normal plant showing that the plant is rich in antioxidant phytochemicals.

Table 2: Vitamins and Minerals Factors of the plant *Solanum nigrum*

Factors	Solanum nigrum		
	Control	Sublethal Cr	Half of sublethal Cr
Total Phenolics mg/100g	900	597.1	710.6
β-Carotene µg/100g	44.0	37.9	41.0
Ascorbic acid µ/100g	490	379	461
Thiamine µ /100g	0.15	0.13	0.14
Total Ash g/100g	3.1	2.10	2.95
K mg/100g	415	322.5	366.0
Na mg/100g	34	27.6	31.4
Fe mg/100g	53	31.9	44.14
Ca mg/100g	434	316	417

Table 3 shows the antioxidant enzyme levels and the percentage antioxidant activity of the plants *Solanum nigrum* plant. The antioxidant activity was found to be the maximum when the plants exposed to control soil (Koppolua *et al.*, 2003). The same has been reduced much in the plants exposed to sublethal Chromium and half of sub lethal Chromium exposed soil. This shows that the free radical scavenging activity is reduced much in the plant exposed to heavy metal contaminated soils (Lowry *et al.*, 1951). The enzymes Superoxide dismutase, catalase and glutathione were increased significantly in the plant sample exposed to heavy metal contaminated soils (Mehra and Tripathi, 1999).

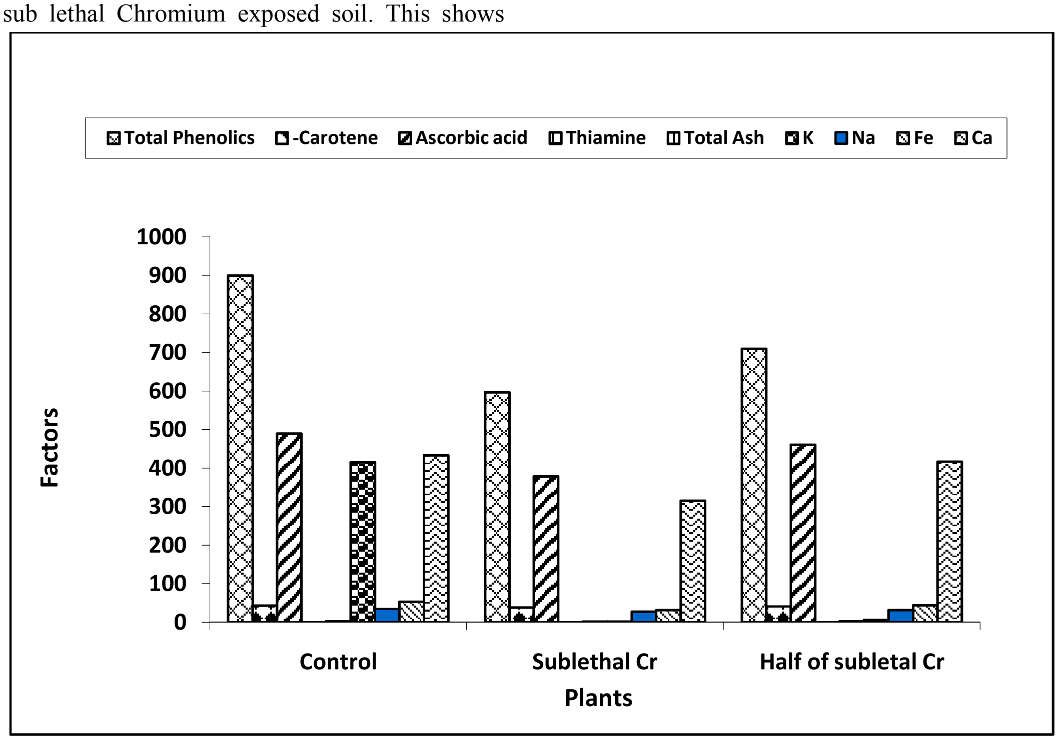

Figure 2: Vitamins and Minerals factors of the plant *Solanum nigrum*

Table 3: Antioxidant properties of the plant *Solanum nigrum*

Factors	Solanum nigrum		
	Control	Sublethal Cr	Half of sublethal Cr
AOA %	110	62	73
SOD µgm/minute/mg protein	510	634	731
GSH mg/g	16.4	17.6	19.5
Catalase µ/mol/min/g	7.54	7.59	6.85

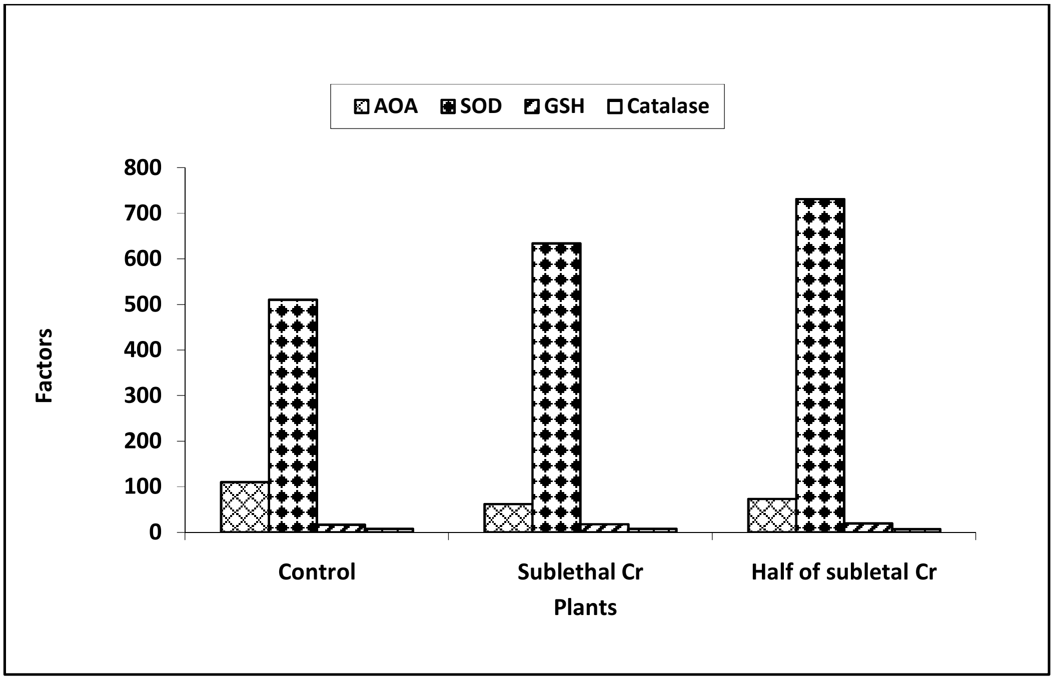

Figure 3: Antioxidant properties of the plant *Solanum nigrum*

Though some heavy metals are essential as micronutrients, uptake of higher concentrations of heavy metal is found to be toxic for plants (Rao and Sresty, 2000). Certain metals are known to produce/act as catalysts for the production of free radicals in biological systems. Many heavy metals like Fe, Cu, Cd, Cr, Zn, etc. have been shown to cause oxidative damage in various higher plants (Reeves, 2003). The availability of heavy metals to plants and, thus, their toxicity depends on complex rhizospheric reactions involving not only exchange processes between soil and plants but also microbial activities (Singh and Ghosh, 2003).

Antioxidative Defences of Plant against Heavy Metals

It is evidence that exposure of plants to excess concentrations of redox active heavy metals such as Fe and Cu results in oxidative injury. The ability of plants to increase antioxidative protection to combat negative consequences of heavy metal stress appears to be limited since many studies showed that exposure to elevated concentrations of redox reactive metals resulted in decreased and not in increased activities of anti-oxidative enzymes (Weckx and Clijster, 1996). Exposure to heavy metals also provoked pronounced responses of antioxidative systems, but the direction of the response was dependent on the plant species and tissue analyzed, the metal used for the treatment and the intensity of the stress. However, some common reaction patterns can be found (Zenk, 1996).

In most cases, exposure to heavy metals initially resulted in a severe depletion of GSH. This is a common response to Cd caused by an increased consumption of glutathione for phytochelatin production. The significance of phytochelatin for protection from heavy metals has frequency been reviewed. For Cd, the formation of Cd-thiolate (Cd-S) complexes in phytochelatins has been shown by previous workers.

The chelated metals are transported to the tonoplast, taken up to active transport systems, and deposited in the vacuole. This mechanism contributes to the protection from heavy metal toxicity in several plant species and in some fungi as well. From the above results it is evident that the heavy metals Chromium affects significantly the biochemical factors, vitamins and mineral factors and antioxidant enzymes in both the plants. Among other species of plants the antioxidant property of *Solanum nigrum* is found to be higher than other plants.

CONCLUSION

In the present work the plants *Solanum nigrum* was exposed to the Chromium metal contaminated soils and the biochemical factors, vitamins and mineral factors and antioxidant factors were tested. The toxicity of the Chromium metal *Solanum nigrum* plant was investigated and the results were tabulated. From the above results it is evident that the heavy metal Chromium affects significantly the biochemical factors, vitamins and minerals factors and antioxidant enzymes in both the plant *Solanum nigrum*. According to review literature plants the overall antioxidant property of *Solanum nigrum* is found to be comparatively higher than other plant.

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