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TREATMENT OF CURCUMA LONGA (TURMERIC) CONTAMINATED WITH HEAVY METALS

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ABSTRACT

Curcuma longa is a perennial herb belongs to family Zingiberaceae and is cultivated extensively in Asian countries. The rhizome is used medicinally as a yellow powder which is used as a flavor in many cuisines and as a medicine to treat many diseases like flatulence, jaundice, menstrual difficulties, hematuria, hemorrhage, and applied as an ointment to treat many skin diseases. The present research study was conducted to know the toxicity nature of heavy metals in plant patrts of *Curcuma longa* and its remediation. Pot culture experiments were conducted with three treatments till productivity levels at Greenhouse of Botanical Garden, Department of Botany, Osmania University, Hyderabad.The three treatments consists of Treatment I control without any addition of heavy metals to the soil, Treatment II - heavy metals spiked into the soil and Treatment. III, 1 % of Calcium Hydroxide added along with heavy metals to the soil. The results showed in when compared to control that Ca $(OH)_2$. In treatment II the high concentrations of heavy metals (Ni, Cd and Cr) are found in leaf and rhizome of *Curcuma longa* when compared with 1% Calcium hydroxide treated soil in (Treatment III). In addition, the plants grown in 1% Calcium hydroxide treated soil, reversed the growth suppression and inhibited the heavy metal toxicity in plants as evidenced by reduced heavy metal concentration plant parts. The study concludes that medicinal plant *Curcuma longa* affected with heavy metals can be treated by using 1% calcium hydroxide.

KEYWORDS: *Curcuma longa*, heavy metals, calcium hydroxide, atomic absorption spectroscopy, remediation, diseases.

INTRODUCTION

The major environmental problem that affects our environment in a wide range is pollution. Among them, toxic metals play an important role and one common toxic metal is cadmium. Heavy metals enters a water supply by industrial and consumer waste, or even from acidic rain breaking down soils and releasing heavy metals into streams, lakes, rivers, and groundwater. Heavy metals contaminated soils are widely spread and concerns have been raised over the potential risks to humans, animals and agriculture crops [1]. From past two centuries the deposition of heavy metals such as Cd^{+2}, Zn^{+2} and Pb^{+2} have dramatically increased in soil.[6] Agronomic applications of pesticides, fertilizers, industrial inputs sewage contamination leads to metal accumulation [12].Heavy metals are of great interest for research purpose with respect to toxicological importance to human health, plants and animals [5, 13,3]. The contamination of heavy metals in environment is serious problem to human health and environment quality [8, 15]. Hydrous iron oxides or manganese oxides reduce the concentration of soluble Cd or Pb in contaminated soil, whereas $Ca(OH)_2$ is added to inhibit the heavy metals distribution in soil. Pot experiment were conducted to know the ability to inhibit the entry of heavy metal in plant parts and to evaluate the effectiveness of most toxic heavy metals in presence of calcium hydroxide and its accumulation in *Curcuma longa.*

MATERIALS AND METHODS

1. Curcuma Longa: Turmeric (*Curcuma longa*) is a perennial herb which grows 3-5 feet of height. It belongs to family zinzgiberaceae (ginger) and comprises about 70 spices [7, 21]. It is cultivated mostly in Asia, India, and China and also in other tropical climatic countries. The plant parts are especially rhizome widely used in medicines. Turmeric has attracted much attention due to its significant medicinal properties [10]. One of the active constituents of turmeric is curcumin (diferuoyl methane) which is a well biologically active compound derived from the rhizome. In addition Curcumin has antioxidants properties [14, 20, 16, 22, 9].

2. Soil Sample Preparation: 20Kgs of black soil was used for the pot experiments, the soil consists of 15.4% of clay, 3.5% of total carbon was maintained at p^H 6.5.

3. Heavy Metal Solution Preparation: The heavy metal solution was prepared in the laboratory by following the [4] guidelines. The different concentrations of heavy metals prepared are cadmium (10ppm), chromium (20ppm), nickel (16ppm). These heavy metals were dissolved in 150 liters of distilled water and sprayed on 600kg of black soil and dried in shade for 10 days for proper mixing of heavy metals in soil.

4. **Ca (OH) $_2$ Solution Preparation**

1.5 kg of 1% Ca $(OH)_2$ was added to the 300kgs of soil spiked with heavy metals.

5. **Treatments:** Treatment-I: 20 Kg of black soil was filled in 15 clay pots as control, Treatment-II: 20 Kg of black soil spiked with heavy metals was filled in 15clay , Treatment-III: 20 Kg of black soil spiked with heavy metals and 1% Ca (OH) $_2$ was filled in 15 clay pots.

6. **Plant Material:** *Curcuma longa* (Turmeric) OB Var rhizomes were collected from Regional Agriculture Research Station, Warangal, Telangana State, India and plants were grown in earthen pots in month of April 2013 at Greenhouse of Botanical Garden, Department of Botany, and Osmania University Hyderabad. The plants were grown without pesticides, fertilizers and no addition of any type of manure. The crop was harvested after productivity level.

7. Acid Digestion of Plant Samples: The plant material of *curcuma longa* such as rhizome and leaf were taken after harvesting and the plant material was dried, grinded into fine powder. The 10mg of powder (Rhizome and Leaf) was digested in triple acid ($HCLO_4$: HCL: HNO_3 (5:1:1),) [2]. And heated at 80-100^{o}C for 3 hours on hot plate. After digestion, samples were diluted with 20ml milky water (Millipore instrument) and incubated for about 24 hours and analyzed directly by using Atomic Absorption Spectrophotometer (Model: Perkin Elmer Analyst 100) for detection of Ni, Cd and Cr.

RESULTS

The treatments of curcuma longa contaminated with heavy metals are given in table (1) and are shown in fig 1, 2 and 3.

Table - 1: Treatment of *Curcuma longa* with Calcium Hydroxide

Name of the plant parts	Heavy Metals	Treatment I (Control soil)	Treatment II (Soil + Heavy metals)	Treatment III (Soil + Heavy metals + 1%Ca(OH)$_2$
Rhizome		Mean ± S.D	Mean ± S.D	Mean ± S.D
	Ni	0.348±0.0182	0.396±0.0451	0.369±0.0430
	Cd	0.022±0.0034	0.050 ±0.0026	0.023±0.0037
	Cr	0.139±0.0614	0.292±0.1099	0.183±0.0929
Leaf	Ni	0.250±0.0092	0.263±0.0377	0.241±0.0186
	Cd	0.015±0.0010	0.046±0.0033	0.017±0.0024
	Cr	0.0461±0.026	0.085±0.0204	0.0542±0.039

Fig (1) Treatment-I Control soil

Fig (2) Treatment-II Soil heavy metals

Fig (3) Treatment-III

Soil +heavy Metals+1% Ca (OH)$_2$

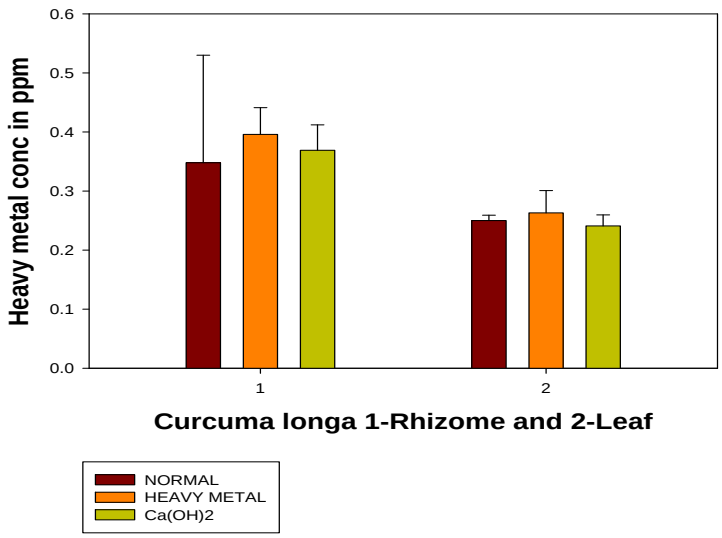
The three treatment results from the pot experiments reveal that concentration of

I. **Nickel**

It was observed that the plants grown in control soil, the concentration of Ni in rhizome was 0.348± 0.0182mg/kg, in leaf0.250±0.0092, in heavy metal treated soil, the Ni concentration

in rhizome was 0.396±0.0451mg/kg, in leaf 0.263±0.037where as plants grown in soil with heavy metal + 1% $Ca(OH)_2$ the Ni concentration in rhizome was 0.232±0.0063mg/kg, leaf0.241±0.018mg/kg, The high concentration of Ni in soil causes various physiological alternations and diverse toxicity symptoms which was observed in treatment II. No physiological alternation was observed as necrosis or chlorosis in treatment - III [25, 18, 19]. Thus, in *Curcuma longa* concentrations of nickel in rhizome and leaf are within the permissible limit. Hence, it is recommended that application of 1% Ca $(OH)_2$ is a good barrier to stop heavy metal entry into *Curcuma longa*.

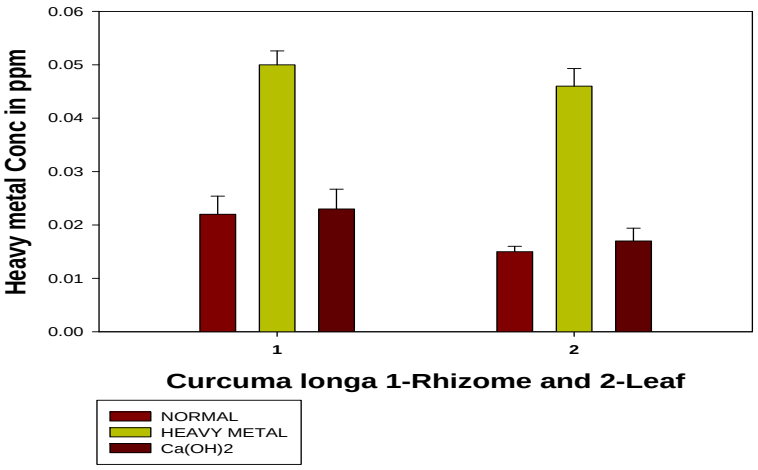
Graph-1 Ni-uptake and remediation of curcuma longa.



II. **Cadmium**

Germination and seedling establishment are vulnerable stages in the plant life. Among top 20 highly toxic heavy metals Cadmium (Cd) has been ranked No.7 [24]. The concentration of cadmium in plant grown in control soil is rhizome was 0.022±0.003mg/kg, in leaf 0.015±0.001mg/kg. Plants grown in heavy metal treated soil, the Cd concentration in rhizome was 0.050±0.0026mg/kg, in leaf 0.046±0.003mg/kg, and in plants grown with heavy metal +1% $Ca(OH)_2$ Cd concentration in rhizome was 0.023±0.003mg/kg, in leaf 0.017±0.002mg/kg. Regulatory limit of cadmium (Cd) in agricultural soils is 100mg/Kg. Thus, in *Curcuma longa* concentrations of Cadmium in rhizome and leaf are within the permissible limit (0.2-0.81ppm). Hence, it is reveals that application of 1% Ca $(OH)_2$ is a good inhibitor for heavy metal entry into *Curcuma longa*.

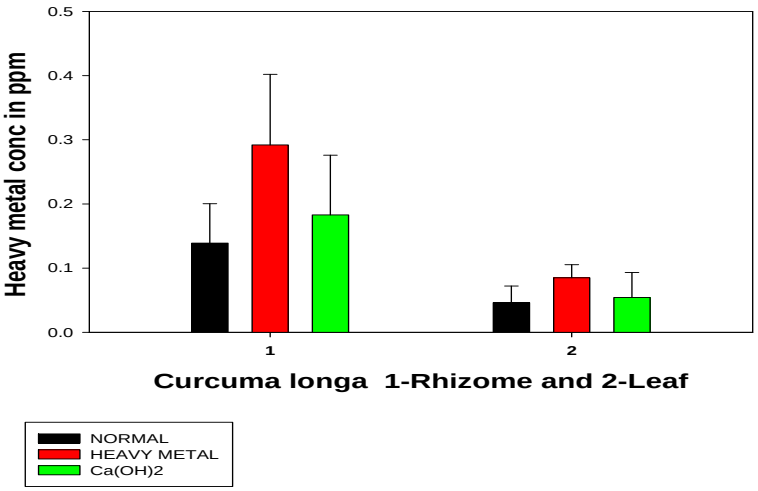
Graph II- Cd -uptake and remediation in Curcuma longa.



III. **Chromium**

The concentration of chromium in rhizome was 0.139 ±0.061mg/kg, in leaf 0.046±0.026 mg/kg, when plants grown in control soil. Plants grown in heavy metal treated soil, the Cr concentration in rhizome was 0.292 ±0.109mg / kg, in leaf 0.085±0.024mg / kg, and in plants grown with heavy metal +1% Ca (OH) $_2$ chromium concentration in rhizome was 0.183±0.092mg/kg, in leaf 0.054±0.039mg. Chromium is a heavy metal that causes serious environmental contamination in soil, sediments and ground water. Thus, in comparison of metal levels in the crop plants investigated with those proposed by [11] showed that Curcuma *longa* concentrations of chromium in rhizome and leaf are within the permissible limit. Hence, the results depicted that the application1 of % Ca (OH) $_2$ is a good barrier to stop heavy metal entry into *Curcuma longa*.

Graph III- Cr- uptake and remediation of Curcuma longa



DISCUSSION

The interactions between heavy metals and the properties of soil play an important role in the environment through their decreasing effect on the bioavailability of heavy metals, thus favorably affecting the environment. It has been demonstrated that some plants can actively or passively change H+ excretion under heavy metal stress. Such root-induced changes of rhizosphere pH play a major role in the bioavailability of many pH dependent nutrients, but also potentially toxic metals and a range of trace metals [17]. The interaction between nutrients, heavy metal and soil may occur at the level of plant and/or in the soil. In soil, nutrients and metal interact at the level of precipitation, surface absorption and formation of complexes with organic compounds [23]. Rhizosphere is an important environmental interface connecting plant roots and soil. The influence of root exudates on heavy metal bioavailability and toxicity is a consequence of change in the rhizosphere pH, redox potential and the number and activity of rhizospheric microbes, and the capacity for chelating with $Ca(OH)_2$. Some motile physiological changes would take place when plants are grown under heavy metal conditions, and then make a series of physical and chemical reactions of heavy metals in rhizosphere to affect their transfer in soil-plant system, which may be beneficial to decrease the metal availability and its absorption by plants. Therefore, it is understandable that the study of root rhizosphere has been one of the most important issues in toxicity and tolerance of metals.

CONCLUSION

The *Curcuma longa* is a medicinal plant commonly used in a large number of medicines and have worldwide applications in the treatment of different types of diseases. Thus, it is essentially required that every medicinal plant should be checked for contaminant load before processing it for further pharmaceutical purposes or for local human consumption. The results reveals that the plants growing in polluted areas contaminated with heavy metals can be inhibited or reduced in soil by treating with of 1% $Ca(OH)_2$ and can achieve heavy metals free plants.

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REFERENCES

1. Aliraza Houshmandfar and Farhang Moragheb. American journal of Agriculture Research. 2011; 6(6): 1182 - 1187.

2. Allen, S.E.; Grimshaw, H.M.; Parkinson, J.A.; Quarmby, C. and Roberts, J.D. Chemical analysis In: Champman, S B (ed), Methods in plant Ecology, Black Well Scientific Publication, Oxford. 1976; 424-426.
3. Almeida, A.F.R.R. Valle, M.S. Mielke and F.P. Gomes. Tolerance and prospection of phytoremediator woody species of Cd, Pd, Cu and Cr Braz. J. Plant Phsiol, 2007; 19: 83-98.
4. APHA, Standard Methods for the Examination of Water and Wastewater. 1992.
5. Azevedo. R. &P.J. Lea .Toxic metals in plants Braz.j. Plant Physiolo, 2005; 17:1.
6. Candelone J.P., S. Hong, C. Pellone & C.F. Boutron. Post – industrial revolution changes in large scale atmospheric pollution of the northern hemisphere by heavy metals as documented in cental Greenland snow & ice. J. Geophys. Res. 1995; 100: 16605-16616.
7. Chainani WUN. Safety & anti inflammory activity of Curcumin: a component of turmeric (Curcuma longa). J. Altern Complement Med 2003; 9:161-8.
8. Chen, M. Chau, L. and Ching, K. Oxidative stress in copper treated rice roots. Bot. Bull. Acad. Sin. 2000; 41:99-103.
9. Cohly HH, Taylor A, Angel MF, Salahaudeen AK. Effect of turmeric, turmeric & curcumin on H_2O_2- induced renal epithelial (LLC-PK1) cell injury. Free Radical Biol Med. 1998; 24:49-54.
10. Cousins, M., J. Adelberg, F. Chen and J. Rieck. Antioxidants capacity of fresh and dried rhizome from four clones of turmeric (*Curcuma longa*) 2007.
11. FAO/WHO. Contaminants in codex alimentarius, Vol. XVII, Edition 1. FAO/WHO, Codex Alimentarius Commision, Rome. Taipei, Taiwan). Science Review, London. 1984; 209-223.
12. Her land B.J., D. Taylor and K. Wither. The distribution of mercury & other trace metals in the sediments of the Mersey Estuary over 25 years 1974-1988. Sci. Total Environ. 2000; 253:45-62
13. Jarup L. Hazard of heavy metal contamination Braz Med Bull. 2003; 68:167-182.
14. Kunchandy E, Rao MNA.Oxygen radical scavenging activity of curcumin. Int J Pharmaceut. 1990; 58(3):237-240.
15. Ma, L.Q and Rao, G.N. Chemical fractionation of cadmium, copper, nickel and zinc in contaminated soils. J. Environ. Qual. 1997; 26:256-264.
16. Masuda.T, Jitoe A, Isobe J, Nakatani N, Yonemeri S, Antioxidative & Anti – inflammatory curcumins–related phenolics from rhizomes of Curcuma domestica. Phytochemistry, 1993; 32:1557-1560.

17. P. Hinsinger, C. Plassard and B. Jaillard, "Rhizosphere: A New Frontier for Soil Biogeochemistry," Journal Geo- chemical Exploration, 88: 1-3, 210-213.
18. Pandey.N.Sharma. CP. Effect of heavy metals Co, Ni and Cd^{+2} on growth and metabolism of cabbage .Plant Science. 2002; 163:753-758.
19. Rahman. H, Sabreen. S. Alam. S. Kawai. S. Effects of nickel on growth and composition of metal micronutrients in barley in nutrient solution .Journal of Plant Nutrition. 2005; 28:393-404.
20. Reddy ACP, Lokesh BR. Studies on the inhibitory effects of curcumin & eugenol on the formation of reactive oxygen species & the oxidation of ferrous iron. Mol cellular Biochem. 1994. 137 (1): 1-8.
21. Smart, J. & N.W. Simmonds .Evolution of crop plants Longman, Edinburgh. 1992; 333.
22. Unnikrishnan MK, Rao MN. Curcumin inhibits nitrogen dioxide induced oxidation of haemoglobin .Molecular & cellular biochemistry. 1995; 10:35-37.
23. V. Pantazis, I. Kalavrouziotis and I. Deligiannakis. "Cu- Zn Accumulation on Soil Plant System Irrigated with Wastewater," Proceedings in IWA Facing Sludge Diver- sities: Challenges, Risks and Opportunities, Antalya, 2007; 28- 30.
24. Yang X, Long X, Ye H, He Z, Calvert D, Stoffella P. Plant Soil 2004;259: 181–189.
25. Zornoza. P. Robles .S. Martin, N. Allevation of nickel toxicity by ammonium supply to sun flower plants .Plant and Soil, 1999; 208:221-226.