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ORIGINAL RESEARCH

Comparative Analysis of Effect of Nickle and Cadmium on In-Vitro Cultures of *Datura inoxia*

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Abstract: Pollution of the globe with toxic heavy metals has increased dramatically since the foundation of the industrial revolution. Several studies have been conducted to evaluate the effects of different heavy metal concentrations on living plants. Numerous in vitro experiments have focused on the effects of high concentrations of heavy metals on the regeneration of plants viz. accumulator, tolerant or sensitive to industrial pollution. Selection of plants under natural conditions of environmental pollution or in vitro may result in the selection of clones, accumulator to toxic metal ions. This piece of research was conducted to assess the phytoremediation potential of *Datura inoxia*. Effect of increasing concentrations of heavy metal such as Cadmium and Nickel was determined using in vitro established cultures of Datura. Present study has shown that both the metals have somewhat similar effect on Datura and this is a good accumulator plant for the use in phytoremediation.

Keywords: Accumulator; Cadmium; Datura; Heavy Metal; Nickle; Phytoremediation; Pollution; Plants

1. Introduction

All living system requires special mechanisms for transport and handling toxic metals to keep them free from them. Severe toxicity occurs in human due to environmental pollution of heavy metals by soil or water contamination and due to occupational exposure. Some of these metals are useful to us in low concentrations but are highly toxic in higher concentrations (Henry, 2000). Environmental contamination in today's scenario posing a thrust of remediation technologies, for these traditional methods includes mainly mechanical or physio-chemical remediation methods. According to Weis and Weis (2004)heavy metals accumulated in plant tissues can cause toxic effects on plants when they are translocated to above ground tissues. In 2005, Ghosh and Singh focused on phytoremediation of heavy metals and utilization of byproducts of that phytoremediation process. According to him, phytoremediation is an aesthetic, cost effective, and ecofriendly, approach most suitable for developing countries like India. Baker and Whiting (2002) have found that the success of phytoremediation or phytomining depends on the availability of plant species, mainly those native to the region of interest and are able to tolerate and accumulate high concentrations of heavy metals. In 2009, Sandra King et al., uses tissue culture to develop plants with acid soil, heavy metal tolerance, potentially for hard-rock mine land reclamation.

Nickel has hazardous impact on human health. Acute poisoning of Nickel sulfate or Nickel carbonyl causes death due to cardiac arrest, pneumonia or brain hemorrhage, Allergies (most common health effects), adverse pregnancy outcomes, Cancer etc. Nickel is a white magnetic hard metal used in alloys with copper, Chromium, iron and zinc. Widely used in industry like fuel production, electroplating, pigments, ceramics, household appliances, food production, making jewelry, heat exchangers, magnets, coins, medical prostheses, batteries, etc. Nickel is a member of the transition series and belongs to group VIII B of the periodic table along with iron, cobalt, palladium, platinum and five other elements. It has no corrosive effect by air, water and

alkali, but it dissolves readily. Nickel is a naturally occurring element that can exist in various mineral forms. It is the 24^{th} most abundant element in the Earth's crust, and comprises about 3% of the earth's composition. Although it can exist in several different oxidation states such as Ni (II), Nickel in the +2 valence state. Other valences (-1, +1, +3, and +4) are also encountered, in less frequently manner (You Ng R. A, 1995). More than 80 % of Ni emissions are anthropogenic in origin, and land disposal of fly ash and urban sewage sludge can be a major source of Ni in soils. Nickel is somewhat mobile in the soil profile and its soil chemistry is based on the divalent $Ni_2{}^+$, which is mainly soluble at low pH. Concentrations of Ni in plants generally reflect soil concentrations (Mcgrath et al., 1995). Cadmium generally has no biological role and it is highly toxic to plants and animals. The natural concentration of Cadmium in soil is 0.06-1.1 mg kg" but increased by industrial exhaust and incineration of waste (Alloway et al., 1995). It is present in higher concentration at surface horizons of soils with organic matter and can move down according to soil properties. The $Cd_2{}^+$ free ion is the principal and most phytotoxic species in soil solution, but its organic and inorganic complexes also present. (Alloway et al., 1995). Increase in soil pH decreases solution Cd concentrations by increased adsorption density, hydrolysis and pH dependent negative charge.

The lungs can damage by breathing of high levels of Cadmium. Food or drinking water contaminated with Cadmium causes irritation in the stomach which leads to diarrhea and vomiting. Even lower levels of Cadmium with long-term exposure results in accumulation of Cadmium in the kidneys and subsequent kidney damage. Long-term effects of the same Lead to lung damage, high blood pressure and weak painful bones. The U.S. Environmental Protection Agency has determined that Cadmium probably causes cancer in humans and associated with lung cancer.

The adverse effects of Heavy metals in plants are (Gardea-Torresdey et al., 2005)

- Cadmium lowers seed germination, lipid content and plant growth, but can elicit the phytochelatins production, which is a metal binding peptide having important role in cadmium detoxification mechanism in plants.
- Nickel reduces seed germination, protein production, chlorophyll and enzyme production, and accumulation of dry mass, but increases the amount of free amino acids.

2. Materials and Method

Selection of plants under natural conditions of environmental pollution in vivo or in vitro may result in the selection of clones tolerant or accumulator to toxic metal ions (Gori et al., 1998); Barnabas et al. (2000). In vitro selection of plants tolerant to toxic ions present in the soil may lead to production of plants that are better adapted to accumulate and remediate environmental pollution along with rhizospehere flora (Khan et al., 2005) and can enable better management of degraded soil e.g. industrially contaminated areas.

In vitro cultures of *Datura inoxia* were used for this experiment. Standard M. S. Media with increasing concentrations of Cadmium and Nickel was used for established cultures of *Datura inoxia*, Shoot cultures were exposed to different concentration of Cadmium and Nickel (0-50 mg/l). Percentage of survival was measured after 10 – 20 days of exposure. Differential response in Percentage of survival was noted. *Datura inoxia* was more tolerant towards Cadmium as compared to Nickel (Waoo et al., 2015). Analysis of data has shown that *Datura inoxia* has percentage of survival on up to 50 mg/l for both Cadmium and Nickel.

3. Observations and Results

The effect of all treatments of heavy metals was tabulated below in Figure 1. For the assessment of effect of these heavy metals here percentage of survival of culture in various treatments of heavy metals was taken in to consideration. Toxicity of nickel may have effect on number of biological and physiological processes in plants. Wilting and leaf necrosis have been described as typical visible symptoms of nickel toxicity Nickel concentration in uncontaminated

soil is between 5-50 mg kg^{-1}, and in the plants, is between 0.4-3 mg $kg^{-1.}$ Nickel is an important cause of contact allergy. Nickel Sulphide dust and fumes is believed to be carcinogenic. Figure 1 shows the graphical representation of percentage of survival of Datura indicating the different pattern of growth in increasing concentrations of Nickel viz. 0.1 to 50 mg/l. *Datura inoxia* shows the better response of survival. At the highest concentration of Nickel viz. 50 mg/l, *Datura inoxia* shows 40% of survival in culture having 50mg/l media.

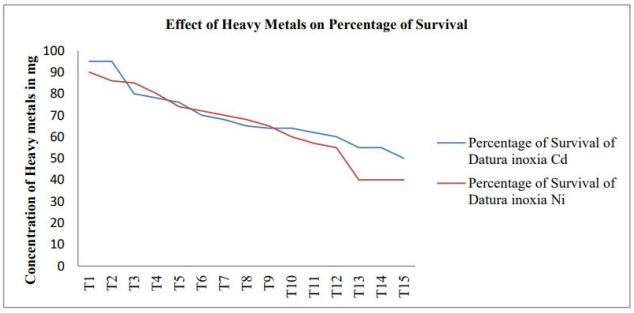

Figure 1. Effect of Increasing Concentrations of Cadmium and Nickel on *Datura inoxia*

4. Conclusion

The plants suited for phytoremediation should be are fast growing and is able to produce a large amount of biomass. However, many potential plants lack these characteristics. Thus, the possibility to produce new plants through transgenic methods is a good choice and this can be achieved through analyzing and manipulating the parameters at in vitro scale then the field scale. Present experiments aimed to analyze the effect of heavy metals, present in the industrial contaminated sites such as cadmium and nickel on the growth of those plants grown at the sites, in vitro. This may enable selection of plant with a higher accumulator to industrial pollution. These plants were proven to be a great experimental material for studies on principles and mechanisms of plant and toxic metal ions interactions.

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