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Toxic Effect of Cadmium Chloride on the Carbohydrate Content of *Andrographis paniculata* (Burm.F)

[1]Irfan Rashid Thokar, [2]S.D Singh & [2]Bharty Kumar

[1,2,3]Department of Botany Govt. MVM Bhopal MP (India)

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Corresponding Author
Email: irfanthakur08@gmail.com

ABSTRACT

Cadmium is one of the most toxic heavy metals present in soil as a result of use of insecticides, fungicides and commercial fertilizers and also present in sludge which is used for irrigation. An attempt has been made to assess the response of *Andrographis paniculata* under influence of Cadmium Chloride ($CdCl_2$) with special reference to carbohydrate content. In the present study the effect of different concentrations of Cadmium Chloride on the carbohydrate content of *Andrographis paniculata* was estimated and compared with the carbohydrate content of untreated plants. The study results revealed that Cadmium adversely and significantly ($p<0.05$) influenced the carbohydrate content of plant on increasing the concentration of Cadmium. In control the carbohydrate content was 51.75µg/ml, whereas in cadmium treated plants the carbohydrate content was decreased in the range of 29.57 µg/ml at 10mg, 25.81 µg/ml at 20mg, 23. 04 µg/ml at 30mg, 17.41 µg/ml at 40mg and15.76µg/ml at 50mg/kg of cadmium. The results clearly indicated that toxicity of cadmium adversely affected the metabolism of plants.

1. Introduction

Rapid industrialization and modernization around the world have produced the adverse consequence of releasing toxic wastes to the environment. Metal pollutants are derived mainly from industrial and agricultural activities. Heavy metal toxicity means excess of required concentration or it is unwanted which were found naturally on the earth, and become concentrated as a result of human caused activities, enter in plant, animal and human tissues via inhalation, diet and manual handling, and can bind to, and interfere with the functioning of vital cellular components. Heavy metals were significant environmental pollutants; their toxicity is a problem of increasing significance for ecological, evolutionary, nutritional and environmental reasons. ''Heavy metals'' in a general collective term, applies to the group of metals and metalloids with atomic density greater than 4 g/cm3, or 5 times or more, greater than water (Hawkes, 1997).

However, chemical properties of the heavy metals are the most influencing factors compared to their density. Among all toxic heavy metals, cadmium ranks the highest in terms of damage to plant growth and human health. Daily consumption of Cadmium contaminated foods poses a serious risk to human health. While in plants, Cadmium produces alteration at various stages of physiological processes resulting growth retardation, inhibition of enzymes, and altered stomatal action. Cadmium is easily taken up both active and passive pathways by plants and affects several metabolic activities in different cell compartments, especially in the chloroplasts. These deleterious effects include the inhibition of photosynthesis, such as biosynthesis of chlorophyll (Stobart *et al*.,1985;) and functioning of photochemical reactions . Cadmium reduces plant growth by interrupting the plant photosynthetic activity and nutrient balance (Zhang *et al*.,2002; Shamsi *et al*., 2010) and also interferes with the uptake, translocation, and plant use of water and mineral nutrients (Shamsi *et al*., 2007). Cadmium ions compete with most nutrients such as K, Ca, Mg, Fe, Mn, Cu, Zn, and nickel (Ni) across the same trans-membrane carriers (Clarkson & Luttge 1989; Rivetta *et al*., 1997; Sanita di Toppi & Gabbrielli 1999). Although Cd is not essential for plant growth, but it is readily taken up by roots and accumulated in plant tissues at high levels (Prasad, 1995). Many experiments described that cadmium (Cd) is a non-essential toxic heavy metal which produces physiological and morphological alterations in plants (Chaoui *et al*., 1997). Cadmium (Cd), being a highly toxic metal pollutant of soils, inhibits root and shoot growth and yield production, affects nutrient uptake and homeostasis, and is frequently accumulated by agriculturally important crops and then enters the food chain with a significant potential to impair animal and human health (di Toppi and Gabrielli, 1999). Excess of cadmium causes a number of toxic symptoms to the plants, viz. growth retardation, inhibition of photosynthesis, induction and inhibition of enzymes, altered stomatal action, efflux of cations and generation of free radicals (Chen and kao, 1995) . Cadmium has been shown to affect various aspects of metabolism indifferent plant systems (Shah and Dubey, 1997). In the present study, the effect of cadmium on the carbohy drate content of *Andrographis paniculata* was examined by exposing the medicinal plant to various concentrations of the cadmium.

2. Materials and Methods

Plant material: The certified seeds of the *Andrographis paniculata* plant were purchased from the Vindhya Herbal Testing Laboratory and Nursery Bhopal, M.P India in the Month of January. These Certified seeds were sown in the month of June under controlled conditions in pots in the mixture of soil, sand and vermicompost material. The experiment was carried upto 100 days. After one month of establishment and normal growth of the plants raised from the seeds the plants were grouped and treated with different concentrations of the cadmium in the form of Cadmium chloride and a separate untreated group was also raised for comparison. The stock solution of cadmium were prepared and were given in the ratio of 10mg, 20mg, 30mg, 40mg and 50mg/kg of soil to the different groups respectively in different time intervals. The first dose were given after 30 days of normal growth. After 100 days of establishment test for Carbohydrate estimation was done by Anthrone method in both treated as well as control group (untreated).

Estimation of Carbohydrate content

Carbohydrate estimation was done by Anthrone method. 100mg of leaves was weighed and extracted by methanol. The sample was hydrolyzed with 5ml of 2.5N Hcl by keeping it in water bath for 3hrs at 100^{0}C. After cooled it to room temperature, the sample was neutralized with sodium carbonate powder. The volume to 10ml was made and then centrifuged for 10 minutes at 10,000 rpm. The supernatant was collected and 0.1-to 1ml was used for analysis. 4ml of anthrone reagent was added and heat for 10 minutes in water bath. Absorbance was read at 630 nm by using Double beam Spectrometer. Glucose was used as standard. The total carbohydrate content was expressed in µg/ml.

3. Results and Discussion

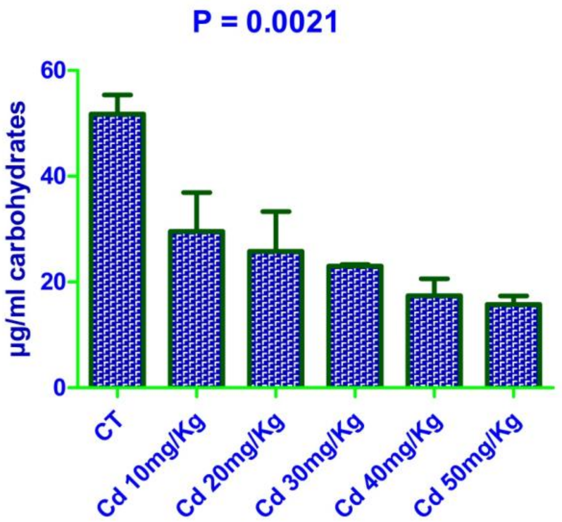

Fig.1: Effect of different concentrations of $CdCl_2$ on the Carbohydrate content of *Andrographis paniculata*

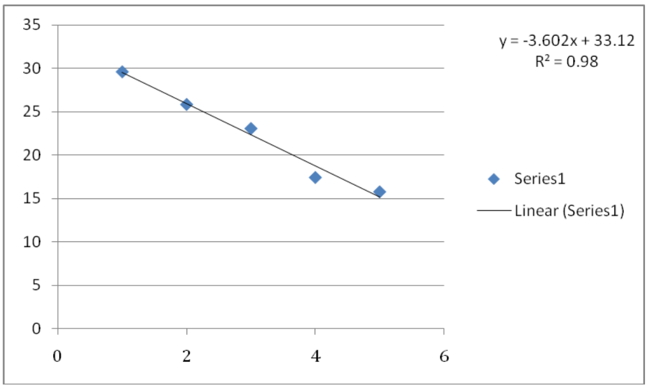

Fig.2: Linear regression and square of correlation coefficients between carbohydrate content and dose of Cadmium in the fresh leaves of *Andrographis paniculata.*

The results related to the carbohydrate content are depicted in Fig. 1 and Fig.2 which revealed that with the increase in cadmium concentration, the carbohydrate content of *Andrographis paniculata* was decreased . In control the carbohydrate content was 51.75µg/ml, whereas in cadmium treated plants the carbohydrate content was decreased in the range of 29.57 µg/ml at 10mg, 25.81 µg/ml at 20mg, 23. 04 µg/ml at 30mg, 17.41 µg/ml at 40mg and15.76µg/ml at 50mg/kg of cadmium. The decrease in total sugar content of stressed leaves probably corresponded with the photosynthetic inhibition or stimulation of respiration rate. The negative effect of heavy metals on carbon metabolism is a result of their possible interaction with the reactive centre of ribulose bisphosphate carboxylase (Stiborova *et al*., 1987). These results were corroborating the results of John R *et al*., (2008) who observed that the decrease in total carbohydrate content of stressed leaves on Cadmium treatment is probably corresponded with the photosynthetic inhibition or stimulation of respiration rate in *Lemna polyrrhiza* L. Results of Verma *et al*., (2012) also shows that increasing concentration of Cadmium Chloride treatment increases the total soluble sugar content in *Vigna radiata* seedlings.

4. Conclusion

In the present study, the effect of cadmium chloride on the carbohydrate content of *Andrographis paniculata* was examined by exposing the medicinal plant to various concentrations. It was found that with the increase of cadmium concentrations, the carbohydrate content was decreased simultaneously. From the results, it may be concluded that the exposure of cadmium poses a great risk to the metabolism of the plants.

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