J. Phytol. Res. **14** (2) : 131-134, 2001

ALUMINIUM TOXICITY PRODUCES BIOCHEMICAL LESIONS IN *HYDRILLA VERTICILLATA*

M. H. KHAN and S. K. PANDA

Plant Biochemistry Laboratory, School of Life Sciences, Assam (Central) University, Silchar-788011, Assam, India.

Imposition of aluminium toxicity on an aquatic plant *Hydrilla verticillata* was investigated. With the increase in aluminium concentrations, a decrease in chlorophyll and carotenoid content was visible. Proline accumulation was uniform with the increasing concentrations. A decrease in peroxide content with a simultaneous decrease in CAT, GPx and SOD activities was recorded for hydrilla under aluminium toxicity.

Keywords : Aluminium; Antioxidants, *Hydrilla verticillata.*

Introduction

Heavy metals occur naturally in the environment and mostly in the lithosphere and hydrosphere where they pose a threat to the terrestrial and aquatic organisms[1]. *Hydrilla*, one of the aquatic plant can be exposed to various heavy metals present through soil leaching. Aluminium, one of the toxic metal is known to affect the plant growth, metabolism and cause oxidative damage[2-4]. Metal ions are implicated for the production of oxidative stress in various plants[5-8]. The present experiment aims at understanding the oxidative damage causing biochemical lesions in hydrilla under aluminium toxicity.

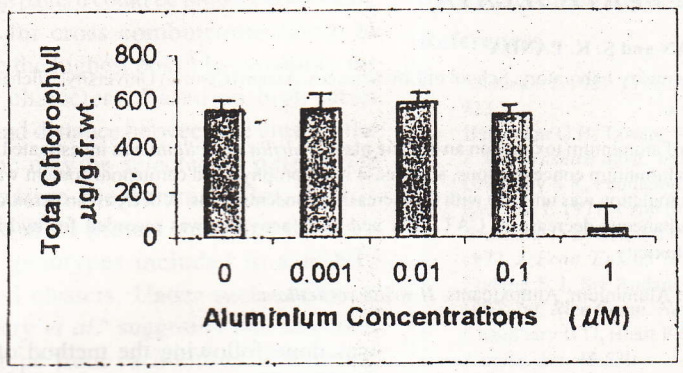
Materials and Method

Hydrilla verticillta L. an aquatic plant was collected from a nearby uncontaminated pond and grown in laboratory conditions for 4 days. Freshly growing hydrilla plants were taken and kept in Petriplates containing different concentrations (0, 1, 10, 100 and 1000 μ M) of heavy metal solution of Aluminium chloride ($AICI_3$). Petriplates were kept under continuous light at 25 ± 2°C for 48 hours. Light was provided with white fluorescent tube lights (Philips 36 W TLD) giving a photon flux density (PFD) of 52 μ E m^{-2} s^{-1} (PAR). After every 48 hours plants were sampled for various biochemical and enzymic estimations.

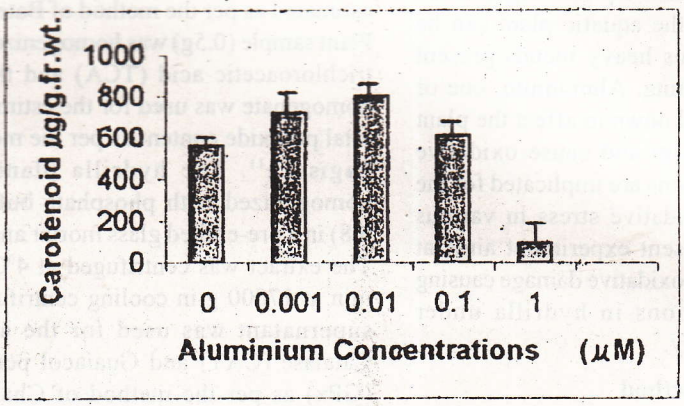
The extraction of chlorophyll and carotenoid using 80% cold alkaline acetone was done following the method of Arnon (1949)[9]. The plants (treated and untreated) were homogenized with 3% aqueous sulfosilicylic acid and centrifuged at 3000g for 10 min. Proline from the supernatant was estimated as per the method of Bates et al.[10] Plant sample (0.5g) was homogenized in 5% trichloroacetic acid (TCA) and the same homogenate was used for the estimation of total peroxide content as per the method of Sagisaka[11]. The hydrilla plants were homogenized with phosphate buffer (pH 6.8) in a pre-chilled glass mortar and pestle. The extract was centrifuged at 4°C for 15 min at 17000 g in cooling centrifuge. The supernatant was used for the assay of Catalase (CAT) and Guaiacol peroxidase (GPx) as per the method of Chance and Maehly[12]. The assay of Superoxide dismutase (SOD) was done as per the method of Giannopolitis and Ries[13]. Values presented in the experiment are mean of three independent experilments with five replicates each ± standard error of mean (S.E.M.).

Results and Discussion

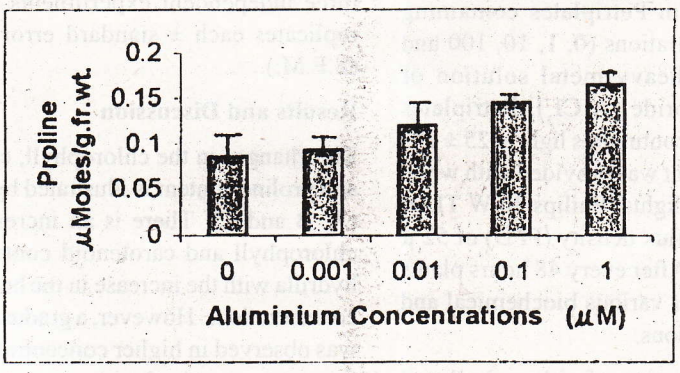
The changes in the chlorophyll, carotenoid and proline content is illustrated by Figure 1 (A, B and C). There is an increase in the chlorophyll and carotenoid content in the hydrilla with the increase in the heavy metal concentrations. However, a gradual decrease was observed in higher concentrations. The minor increase in the pigment content and its subsequent decrease due to a stimulatory



(A)



(B)



©

Fig. 1. (A, B and C). Changes in the total Chlorophyll, Carotenoid and Proline content subjected to different concentrations of aluminium in hydrilla.

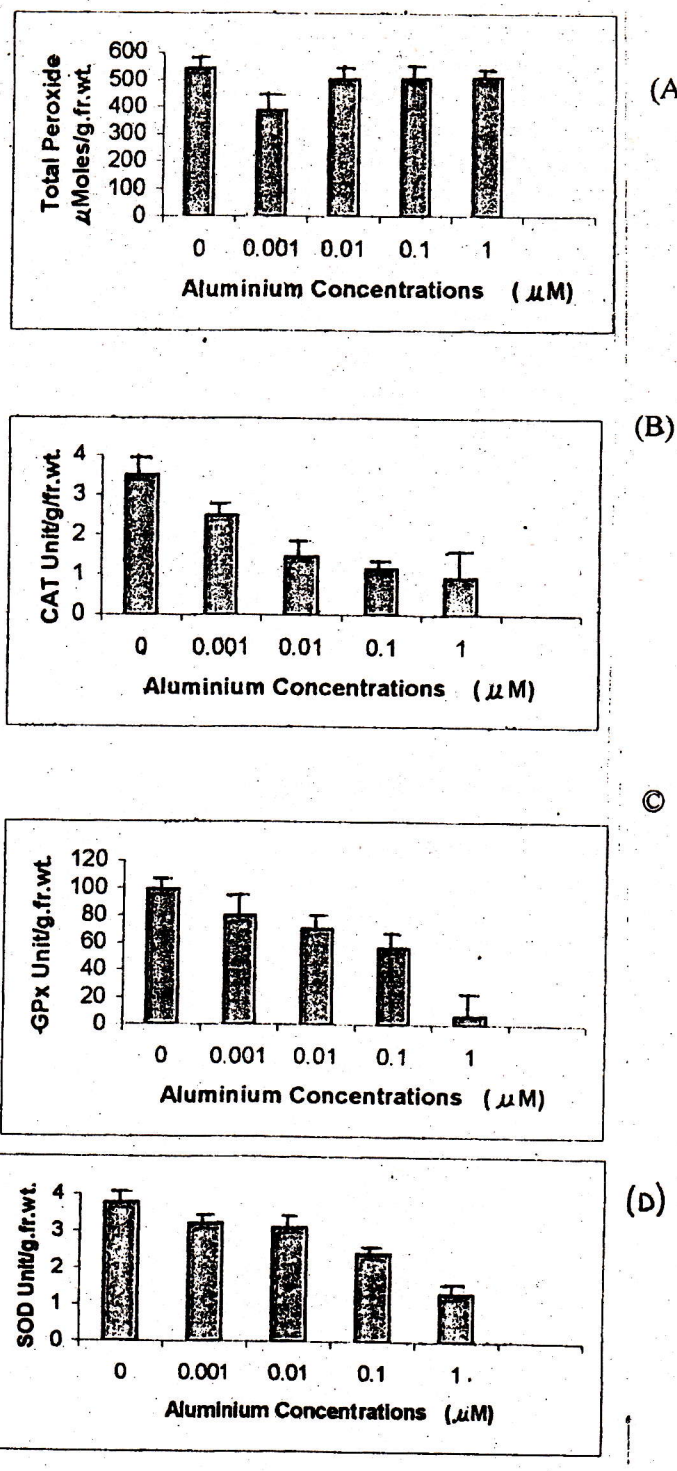


Fig. 2. (A, B and C). Changes in the total peroxide content and the activities of CAT, GPx and SOD subjected to different concentrations of aluminium in hydrilla.

effect on chlorophyll biosynthesis or a metal and plant specific effect as reported for other metals[14,15]. An uniform accumulation of proline, an osmoprotectant was marked with the increase in the metal concentrations from control. The precise mechanism and the significance of proline accumulation in plants under heavy metal stress have been elucidated till date. However, it might be alleviating the metal induced decrease in water potential in the plant tissue[16].

Figure 2 (A, B, C and D) depicts the changes in the total peroxide and activities of Catalase (CAT), Guaiacol peroxidase (GPx) and Superoxidase (SOD) under different concentrations of the heavy metal aluminium. There is a decrease in the total peroxide content followed by an increase with the increase in the metal concentrations. An uniform decrease in the activities of CAT, GPx and SOD was marked with the increase in the aluminium concentrations from control. Though a decrease in SOD activity will generate lesser amount of hydrogen peroxide (H_2O_2) as substantiated by the peroxide accumulation data, a decrease in CAT and GPx in response to metal suggested a possible induction of oxidative stress with a gradual loss of cellular protection measures under toxicity in hydrilla[7,8,17-19].

References

1. Mukherjee S 1981 *Agro's Annual Review of Plant Physiology* (ed.) S.S. Purohit. Pp. 188-246, 1996-97
2. Clark R.B 1997 *Pt. Soil.* **47** 653
3. Foy C D, Chaney R C and White M C 1978 *Annu. Rev. Plant Physiol.* **29** 511
4. Kochian L V 1995 *Annu. Rev. Plant Physiol. Plant Mol. Biol.* **46** 237
5. Aust S D, Morehouse L A and Thomas C E 1985 *J. Free Radic. Biol. Med.* **1** 3
6. Weckx J E J and Clisters H M M 1997, *Plant Physiol. Biochem.* **35** 405
7. Subramanium D 1998 *Ind. J. Plant Physiol.* **3** 240
8. Panda S K and Patra H K 2000 *J. Plant Biol.* **27** (2) 105
9. Arnon D I 1949 *Plant Physiol.* **24** 1
10. Bates L S, Waldren R P and Teare L C 1973 *Pt. Soil.* **39** 205
11. Sagisaka S 1976, *Plant Physiol.* **57** 308
12. Chance B and Maehly A C 1955, *Methods Enzymol.* **2** 764
13. Giannopolitis C N and Ries S K 1977, *Plant Physiol.* **59** 309
14. Krupa Z and Baszynski T 1995, *Acta. Physiol. Plant* **17** 177
15. Ksh Singha L B, Shan M H, Dash M and Panda S K 2000, *Prof. Nat Acad. Sci.* (In Press).
16. Schat H, Sharma S S and Vooijis R 1997, *Physiol. Plant* **101** 477
17. Luna C M, Gonnzalez C A and Trippi V S 1994, *Plant Cell Physiol*, **35** 11
18. Gallego S M, Benavioes M P and Tomaro M L 1996, *Plant Sci.* **121** 151
19. Mazhoudi S, Chaoui A. Ghorbal M H and Ferjani E E I 1997, *Plant Sci.* **127** 129