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Effect of cadmium and lead on growth of symbiotic cyanobacteria isolated from cyanolichens

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ABSTRACT

Axenic cultures of symbiotic cyanobacterial isolates *Aphanocapsa* sp. (NTK28), *Nostoc* sp. (NTK29 and NTY30) were subjected to different concentrations of heavy metals such as cadmium and lead. The concentration of cadmium and lead in the medium was 0.1, 1.0, 10, 100 and 1000 ppm, respectively. The maximum growth rate was observed for the three tested organisms at 0.1 and 1.0 ppm concentrations whereas for the other concentrations no significant growth was observed. In growth concerned with Lead, initially growth could be observed at all the concentrations, but at 15th day growth gradually decreased in *Aphanocapsa* sp. (NTK28) and *Nostoc* sp. (NTK29), whereas there was a gradual increase in growth in *Nostoc* sp. (NTY30).

KEYWORDS

Lichens;
Cyanobacteria;
Heavy Metals;
Cadmium;
Lead.

INTRODUCTION

All organisms must possess mechanisms that regulate metal ion accumulation and thus, avoid heavy metal toxicity. Several resistance mechanisms exist to lessen or prevent metal toxicity. These include resistance to metals that are always toxic to the cell and serve no beneficial role, and resistance to metals such as copper, iron and zinc which are toxic at high concentration but are absolutely essential in trace amount[18]. Presence of toxic metal ions in aqueous solution due to increased industry–urban activity is one of the challenging problems of environment. The common practice for the removal of soluble metal ions includes simple chemical precipitation, ion exchange resins and solvent extraction. The phenomenon of absorption of cation from solution by biological material has been termed as "biosorption" the superiority of biosorbent material over conventional one is well established, owing to their wide working pH range and nonspecific metal binding[20]. Hence, the present investigation was the preliminary study for biosorption and growth stability effect of cyanobacteria isolated from cyanolichens.

MATERIALS AND METHODS

Isolation, Identification and estimation of growth of symbiotic cyanobacteria

A small section of cyanolichen thallus was dipped in 0.1% mercuric chloride solution and repeatedly washed with sterile distilled water, and used for isolation of symbiotic cyanobacteria[16]. Sections of 30–

40 μm thickness were cut with a microtome, placed in 6 cm petri dishes on BG11 medium containing 1.5% agar[2,22] and incubated at 20°C under continuous light at 2000 lux (Osram, universal white, fluorescent light, 40 W). After growth of cyanobiont were observed within the disintegrating thallus sections, they were transferred to fresh agar plates and incubated under the same conditions. Colonies of the cyanobiont were identified using the taxonomic publications of Geitler[4], Desikachary[3] and Starmach[19]. BG11 medium was used for cultivation of symbiotic cyanobacteria[17]. Culture medium was provided with proper light (2000 lux) source. After fifteen to twenty days of incubation period homogenous culture was obtained and this was used as inoculum for further physicochemical studies. Along with standard BG11 medium different concentrations (0.1, 1.0, 10, 100 and 1000 ppm) of cadmium and lead were prepared from stock and about 50 ml each concentration was dispensed in 100 ml conical flasks. After preparation of the media, they were inoculated with homogenous culture of symbiotic cyanobacteria. Growth of cyanobacteria was measured by its chlorophyll content[9].

RESULTS

Effect of cadmium

symbiotic cyanobacterial isolates *Aphanocapsa* sp. (NTK28), *Nostoc* sp. (NTK29) and *Nostoc* sp. (NTY30) were subjected to different concentrations of heavy metal such as cadmium. The concentration of cadmium in the medium was 0.1, 1.0, 10, 100 and 1000 ppm, respectively. The maximum growth rate was observed for the three tested organisms at 0.1 and 1.0 ppm concentrations. The chlorophyll 'a' content (μg/ml) was 11.367, 18.945 and 20.208 in *Aphanocapsa* sp. (NTK28), 3.789, 16.419 and 26.523 in *Nostoc* sp. (NTK29) and 7.578, 11.360 and 12.63 in *Nostoc* sp. (NTY30) at 0.1 ppm cadmium concentration on the 5, 10 and 15th day, respectively. Similarly at 1.0 ppm concentration also, appreciable level of growth was observed (Figure 1). In other concentrations no significant growth was observed.

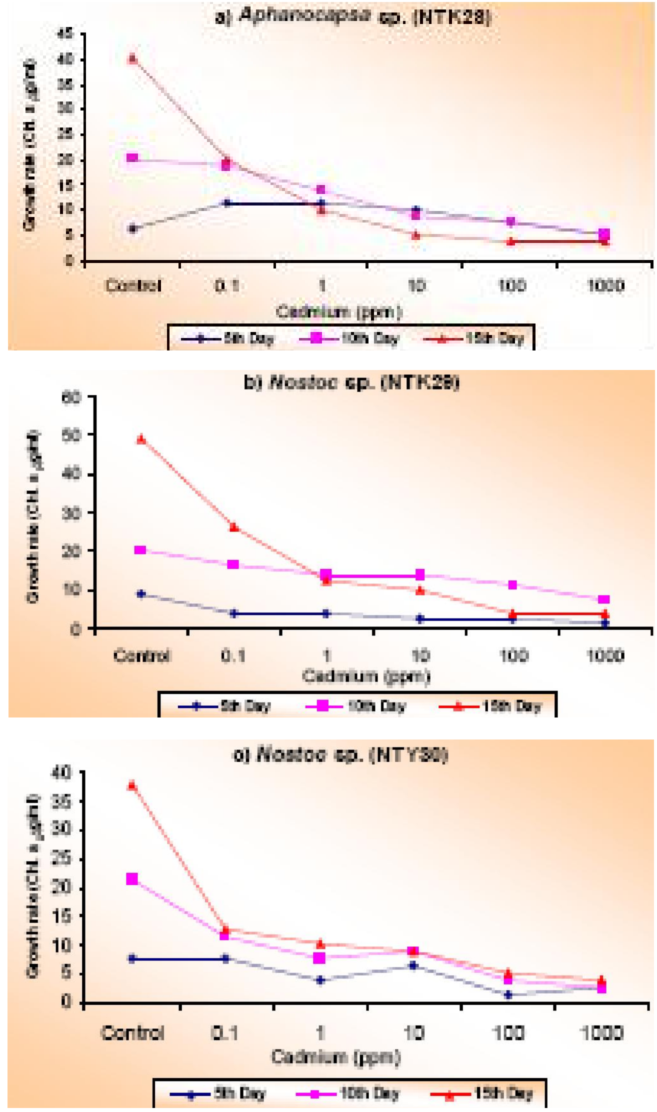

Figure 1 : Effect of cadmium on the growth rate of three different cyanobacterial isolates tested

Effect of lead

Growth rate of three symbiotic cyanobacteria was carried out in various concentrations of the heavy metal lead. At all the concentrations growth was observed initially, but on 15th day growth gradually decreased in *Aphanocapsa* sp. (NTK28), and *Nostoc* sp. (NTK29), whereas there was a gradual increase in growth in *Nostoc* sp. (NTY30). The maximum growth rate was observed with 0.1 ppm concentration of lead. Chlorophyll 'a' content (μg/ml) observed were 15.156 and 31.575 in *Aphanocapsa* sp., 15.156 and 30.312 in *Nostoc* sp. (NTK29) and 5.052, 12.630 in *Nostoc* sp. (NTY30) (Figure 2) on the 5th and 10th day, respectively.

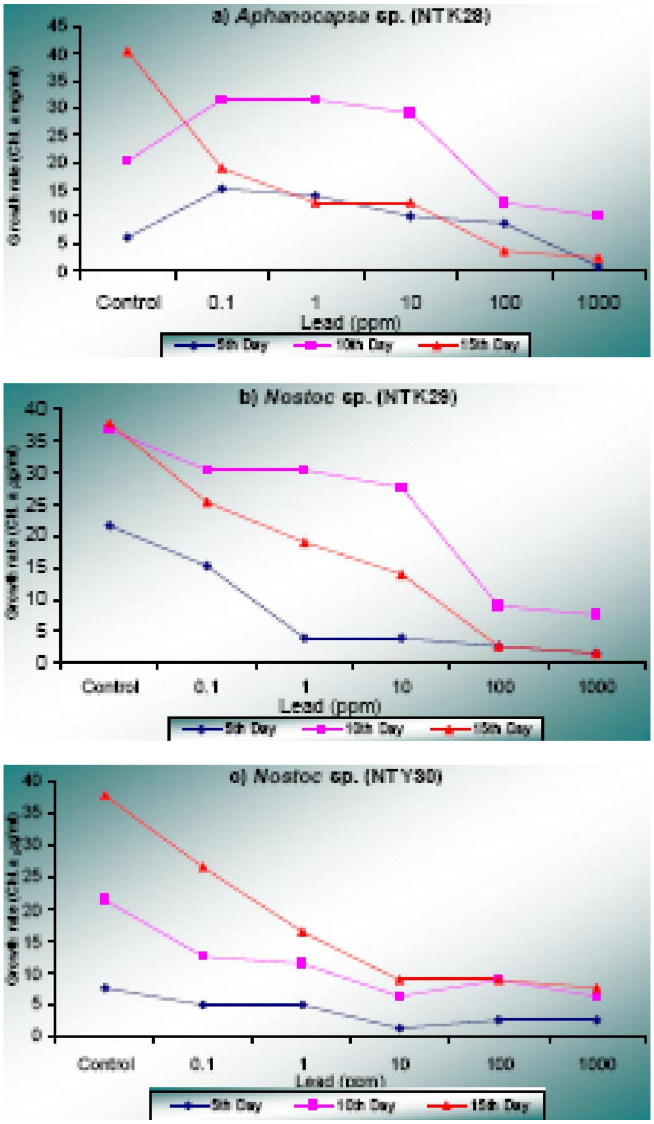

Figure 2 : Effect of lead on the growth rate of three different cyanobacterial isolates tested

DISCUSSION

Effect of cadmium and lead

Tolerance studies in terms of growth were carried out for symbiotic cyanobacteria against different concentrations of heavy metals such as cadmium and lead. The concentrations of heavy metals used in the medium were 0.1, 1.0, 10, 100 and 1000 ppm. Axenic culture of symbiotic cyanobacteria *Aphanocapsa* sp. (NTK28), *Nostoc* sp. (NTK29) and *Nostoc* sp. (NTY30) were exposed to the metals and their growth was analyzed. Axenic cultures of symbiotic cyanobacterial isolates, *Aphanocapsa* sp. (NTK28), *Nostoc* sp. (NTK29) and *Nostoc* sp. (NTY30) were subjected to different concentrations of heavy metal such as cadmium. The maximum growth rate in the three tested organisms was observed at 0.1 and 1.0 ppm concentrations. The chlorophyll 'a' content (μg/ml) was 11.367, 18.945 and 20.208 in *Aphanocapsa* sp. (NTK28), 3.789, 16.419 and 26.523 in *Nostoc* sp. (NTK29) and 7.578, 11.360 and 12.63 in *Nostoc* sp. (NTY30) with respect to 0.1 ppm concentrations on the 5^{th}, 10^{th} and 15^{th} day, respectively. Similarly at 1.0 ppm concentration also some growth was observed (Figure 1 a,b,c). In other concentrations, no significant growth was observed. Growth rate of three symbiotic cyanobacteria was studied at various concentrations of heavy metal lead. Growth was observed initially at all the concentrations, but on 15^{th} day, growth gradually decreased in *Aphanocapsa* sp. (NTK28), and *Nostoc* sp. (NTK29) whereas it gradually increased in *Nostoc* sp. (NTY30). The maximum growth rate was observed at 0.1 ppm concentration. Chlorophyll 'a' content (μg/ml) 15.156 and 31.575 in *Aphanocapsa* sp., 15.156 and 30.312 in *Nostoc* sp. (NTK29) and 5.052, 12.630 in *Nostoc* sp. (NTY30) (Figure 2 a-c) on 5^{th} and 10^{th} day respectively. Environmental contamination by toxic metals is a serious problem due to their accumulation in the food chain and continued persistence in the ecosystem[21]. Free living and immobilized cells of *Nostoc* sp. and *Rivularia* sp. were used for removal of cadmium in aqueous medium[6]. Toxicity of cadmium towards cyanobacteria and algae was reported to be higher than lead because of the many aided destructive effects of the metal[10]. Both the metals have been observed to be toxic to cyanobacteria[14,15]. All organisms must possess mechanisms that regulate metal ion accumulation and thus avoid heavy metal toxicity[18]. Cyanobacteria are highly adaptable organisms that can respond to changing environmental conditions such as temperature, light and metal ion exposure[8]. Even in symbiotic forms, manganese decreased the effective quantum yield of photochemical energy conversion in photosystem II of the bipartite chlorolichen as well as bipartite cyanolichens, but it was increased in tripartite lichen[5]. The cyanobacteria, *Microcystis aeruginosa* and *Microcystis floc- aquae* exist in multicellular aggregates which are surrounded by a colonial capsule or exopolymeric matrix that can adsorb substantial amounts of metal ions[1,7,11,13]. So this type of investigation is primarily needed for the reduction of aquatic pollution by biosorption with cyanobacteria, and this study gives a conclusion that at lower concentrations of heavy metal, the organism can grow effectively than in higher concentrations.

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