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BIOSORPTION OF LEAD FROM AQUEOUS MEDIUM BY CYANOBACTERIUM *NOSTOC CARNEUM* AGARDH

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Abstract: Heavy metals are one of the most potent pollutants which can be toxic to the biotic components of the environment. On account of complications of conventional industrial methods of heavy metal sequestration, biological method to remove the heavy metal from the medium has being extensively researched and used. Many photosynthetic cyanobacterium have been reported to have capacity to absorb the heavy metals present in the surrounding. In the present study, an effort has been made to investigate the efficacy of *Nostoc carneum* in biosorption of Lead (Pb) from aqueous medium. For the experimentation, *N. Carneum* were incubated with lead chloride in the medium and biosorption of Pb by the cyanobacterium was estimated at the time interval of two hours, upto 18th hour of exposure, using atomic absorption spectroscopy. Present study showed a maximum absorption of Lead by the bacterium at 12th hour of incubation, which was then gradually decreased to show minimum absorption at 18th hour. The % uptake of Lead by the bacterium showed an increasing trend on successive days, measured upto 16 days of exposure. Thus, the cyanobacterial strain *Nostoc carneum* can be used as a potential agent for bioremediation and bio- sequestration of heavy metals from the environment.

Index Terms - Cyanobacteria, Lead, Heavy Metal, Nostoc Carneum.

I. INTRODUCTION

With rapid growth of industries and other anthropogenic activities, chances of direct or indirect contamination of soil, water and air by metallic wastes are increasing day-by-day (Sivakami *et al*., 2015). Most of these heavy metals, such as, arsenic, lead, chromium, cadmium, mercury, selenium, etc. are toxic, carcinogenic and mutagenic in nature even at low concentration. Being highly potent environmental pollutants, their removal from the medium becomes a necessity for well- being of the biotic components of the environment (Singh *et al*., 2020). Different physical, chemical and biological methods adopted for removal of heavy metals from the medium have been reported (Yadav *et al*., 2018). Among them, biological method using cyanobacterium have been widely studied. Cyanobacterium and other algal cells have been reported to be helpful in removal of heavy metals via biosorption, bioaccumulation and biotransformation (Jyoti Priya *et al*., 2019; Chen *et al*., 2023). Nath *et al*., 2022 documented a wide range of cyanobacteria that has been extensively used in removal of heavy metal from water and wastewater by using biosorption method. Some of these organisms were; *Anabaena* sp., *Anacystis*, *Aulosira*, *Cyanospiraca* sp., *Microcystis* sp., *Nostoc* sp., etc. (Nath *et al*., 2022). Biosorption of heavy metals using cyanobacteria and algal cell mass have been an active area of research (Sivakami *et al*., 2015; Abdullah Al-Amin *et al*., 2021; Singh *et al*., 2020). Lead (Pb) is one of the widely used metal in industries and its release in water bodies causes severe ill- effects on ecological and human health condition. Apart from industries, other major sources of lead are gasoline vehicles, battery manufacturing units and printing, photographic and explosive materials. Traditional technologies of removal of lead are costly and result in either incomplete removal of the metal or production of toxic sludge or byproduct that needs further disposal (Zinicovscaia *et al., 2015*). Therefore, a cost- effective, potent and biological method for remediation of medium from lead contamination can be beneficial. The present communication deals with the efficacy of Lead sorptive capability of a capsulated exopolysaccharide producing cyanobacterium *Nostoc carneum* in laboratory conditions.

II. RESEARCH METHODOLOGY

II. 1. Biomaterials: Pure strain of *Nostoc carneum* was obtained from school of life sciences, Sambalpur University, Sambalpur and cultured in BG II medium (Stanier *et al*., 1997). The cyanobacteria culture was maintained under continuous white light (2200 lux) at the temperature 25 ± 2°C. under aseptic condition. The culture flasks were subjected to hand shaking intermittently.

II. 2. Culture medium of cyanobacterium: The culture medium was composed of 0.04g $K_2HPO_4.3H_2O$; 0.075g $MgSO_4.7H_2O$; 0.036g $CaCl_2.2H_2O$; 0.006g Citric acid; 0.006g Ferric ammonium citrate; 0.001g EDTA(Disodium magnesium salt); 0.02g Na_2CO_3; 2.86g H_3BO_3; 1.81g $MnCl_2.4H_2O$; 0.222g $ZnSO_4.7H_2O$; 0.049g $CO(NO_3)_2.6H_2O$; 0.39g $Na_2MoO_4.2H_2O$; 0.079g $CuSO_4.5H_2O$ and trace element dissolved in 1000 mL of distilled water. The pH was kept at 7.4. Before the inoculation, the culture medium was subjected to autoclaving for sterilization.

II. 3. Experimental setup: Conical flasks of size 250 mL were used for the experiment. Four sets of flasks each with four replicates containing 50 mL of basalt nutritional media (BNM) were taken. To each flask 2 mL of *N. carneum* culture was introduced. One set of inoculated flask (four flasks) was kept as control. To the other three sets 0.5 ppm of lead chloride ($PbCl_2$) was introduced. All the conical flasks were maintained at the temperature 25 ±2°C under continuous white light (2200 lux). The flasks were sterilized before using them for culture.

II. 4. Heavy metal estimation: The samples were digested in acid mixture and analysed by atomic absorption spectroscope for estimation of heavy metal. Estimation was done at an interval of two hours, upto 18th of exposure.

III. RESULTS AND DISCUSSION

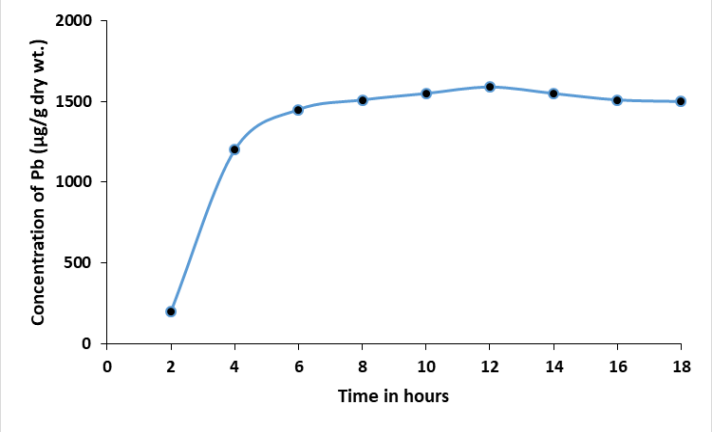

Fig 1: Graph showing concentration of Pb accumulated by *Nostoc carneum* with time.

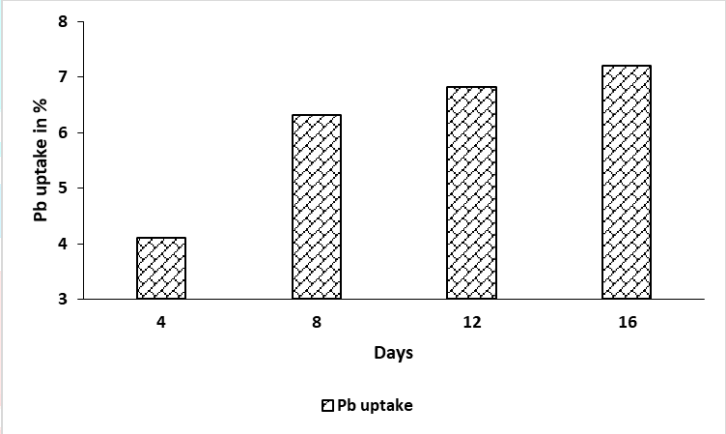

Fig 2: Graph showing % uptake of Pb by *Nostoc Carneum* at different interval.

Sorption of Lead by the cyanobacterium- *Nostoc carneum* was observed to be different at different intervals. The experimental results showed that lead was taken up maximum at 12th hour and the amount was 1590 µg/g. Initially the uptake was in increasing direction. After 12th hour, a decreasing trend was observed and the uptake amount of lead was found to be 1550 µg/g, 1510 µg/g, 1500 µg/g at 14th, 16th and 18th hours of experiment respectively (Fig. 1).

Percent accumulation of Pb by *Nostoc carneum* showed that the lead was removed only by 7.20 % at the end of the experiment, whereas only 4.1 % removal was observed on 4th day of the experiment. On 8th and 12th day of the experiment, percent accumulation of lead by cyanobacteria was 6.32 % and 6.83 %, respectively (Fig. 2).

In case of capsulated exopolysaccharide producing cyanobacteria like *Nostoc carneum* the role of capsular polysaccharide becomes very important in imparting the heavy metal removal or sorption capability to the species. The biosorption of heavy metals like cadmium and lead from aqueous solution using freshwater blue- green algae *Anabaena sphaerica* was reported by Azza *et al*., 2013. Similarly, Lodeiro *et al*., 2006 and Ahmet and Mostafa, 2008 documented the efficacy of brown seaweed *Cystoseira baccata* and green alga *Ulva lactuca* in uptake of Cadmium and Lead from industrial water effluents. Heavy metal removal efficacy of cyanobacterium *Nostoc muscorum* and *Anabaena subcylindrica* in sewage and industrial wastewater effluents have been documented by Mostafa *et al*., 2005. In the same context, Canaza *et al*., 2021 reported the efficacy of dead bacterial biomass isolated from mine water for bisorption of Lead. Corroborating with the present finding, Ghorbani *et al*., 2022 documented a significant role of two species of cyanobacteria, namely, *Nostoc* sp. N27P72 and *Nostoc* sp. FB71, in removal of Lead, Nickel and Copper. Recently, dry biomass of *Nostoc* sp. MK-11 has been studied to be highly efficient for removing heavy metal, especially, Pb metal ions, from the aqueous solution (Kaleem *et al*., 2023).

On account of binding property with heavy metal, especially lead, present in aqueous solution and its removal, cyanobacterium can be used as a promising, cost- effective agent for bioremediation.

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