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Research Article

Accumulation of Chromium by Spirogyra Sp. And it's Effect on Its Biochemical Constituents

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Abstract: The liquid industrial waste possesses serious threat to our environment. In the present study, Spirogyra sp. exposed to various concentrations (2ppm, 5ppm, 10ppm, 20ppm and 30ppm) of chromium metal, and their biochemical constituents (chlorophyll pigment, protein, proline and sugar) were studied. In Spirogyra, sp. highest accumulation was recorded at the 30 ppm concentration level for 21 day duration. The accumulation was depending on cell wall. Therefore, study concluded that spirogyra sp. accumulated high content of heavy metal (Cr) exhibit alteration in biochemical constituents. These findings may be helpful in bioremedial approaches to excess heavy metals in wastewater.

Keywords:Spirogyra sp., Industrial wastewater, Chromium, Biochemical constituents, Bioremediation.

INTRODUCTION

In modern times, anthropogenic sources of heavy metals, i.e. pollution, have been introduced to the ecosystem. Heavy metal pollution can arise from many sources but most commonly arises from the purification of metals, e.g., the smelting of copper and the preparation of nuclear fuels. Electroplating is the primary source of chromium and cadmium. Through precipitation of their compounds or by ion exchange into soils and mud, heavy metal pollutants can localize and lay dormant. Unlike organic pollutants, heavy metals do not decay and thus pose a different kind of challenge for remediation.

Removal of harmful metals from environment, particularly from the aquatic water bodies as well as from the industrial wastewater is essential before their entry into the food chain. Algae have low and simple nutrient requirements, grow rapidly and easily, thrive well in aquatic environment, and can be well studied physiologically as compared to higher plants. Algae produce oxygen for other aquatic biota and oxidation of organic materials present in the wastes making wastewater more favourable for use. There are no reports of dead higher plant materials removing metals, but algae even when dead, efficiently remove metal ions [1]. The term "heavy metal", as used in ecotoxicological studies, encompasses elements that industry commonly uses, that impact aerobic and anaerobic processes, and that researchers generally consider toxic when concentrated [2,3].

Researchers have studied heavy metal bioaccumulation in plants and algae from terrestrial [4], tropic [5], and temperate [6] marine environments. In the marine environment, bioaccumulation from metal contaminated sites can cause marine algal tissue concentrations to exceed such concentrations from non- contaminated sites[6], [7.] The metal can generally be categorized depending on how they affect organisms; "essential" metals are those needed, in trace amounts, for many physiological processes, and "non-essential" metals are those that are potential toxic even at relatively low concentration [8]. The study focused of chromium accumulation and their effect on biochemical constituents of Spirogyra sp. The algal biomass used for biosorption, Spirogyra sp. is a green filamentous, readily available source of biomass for heavy metal removal from wastewater. Biosorption of Cr (III) by microalgae and macroalgae [9].

MATERIALS AND METHODS

Spirogyra sp. was collected from Ankleshwar GIDC area. The collected sample was thoroughly washed under running tap water to remove any epiphytic algae attached to it. In this experiment, intermediate term toxicity test used, the incubation periods were 7, 14 and 21 days. Spirogyra cultures were raised by Pringsheim[10] method. The alga was cultured in soil extract solution pH 7.5 under control condition at $15\underline{+}1^{o}C$ and 16/8 hr light dark cycle. The Cr solutions were prepared by dissolving the salts of chromium chloride ($CrCl_2$) in double distilled water in different concentration like 2, 5, 10, 20 and 30 ppm (In control without metal concentration used) and studied for different incubation periods like 7, 14 and 21 days. In this experiment, alga was digested with $HClO_4$:HNO_3 (1:4 V/V) and diluted with double distilled water. The concentrations of metal were measured by using Inductively Couple Plasma spectrometer, Perkin Elmer Corporation (ICP optima 3300RL).The biochemical parameters like protein [11], proline[12], sugar (GOD-POD test) and chlorophyll[13], algae parameters were recorded for different conditions of metal accumulation.

RESULTS AND DISCUSSION

In the present study, for lowest Cr ion concentration i.e. 2 ppm, the lowest accumulation was 1.0902mg/l by Spirogyra sp. for 7 days exposed duration. However in the highest concentration i.e. 30 ppm for 21 days, highest accumulation was 34.916mg/l. When the Cr concentration was increased the adsorption capacity increased with increase in duration. The maximum capacity of Cr uptake by Spirogyra sp. for 7 days duration was 14.002mg/l at 30 ppm. Concentration of chromium. After 14 days the lowest uptake amount of Cr at 2 ppm was 3.6103mg/l and highest uptake amount is of 14.151mg/l at 30 ppm. In these experiments, at 10 ppm of Cr concentration the uptake amount were 4.9161mg/l, 6.3898mg/l and 8.9110mg/l at 7 days, 14 days and 21 days respectively. In control condition Cr amounts was 0.0091mg/l.

The protein content was decreasing trend after accumulation of Cr day by day (**Fig-1).** The proline content was also decreased after accumulation of Cr in Spirogyra sp. **(Fig-2).** Maximum content of sugar was found at 30ppm of 21 day and minimum content at 2ppm of 7 day experiment period (**Fig-3).** In Spirogyra sp. after accumulation period chlorophyll content was recorded in decreasing trend but, 'chl-a' was higher than 'chl-b'. (**Fig-4).** Enany and Issa [14] investigated the accumulation of proline was correlated it with protein content. The inactivation and denaturation of the metabolic and biosynthetic pathways resulting in the inhibition of photosynthetic pigments was also reported by De Fillippis and Pallaghy [15] and Stratton and Cerke[16].

Table-1: Uptake of Cr ions at various concentrations (ppm) estimated (mg/l) after 7, 14 and 21 days of exposure by Spirogyra.

No.	Concentration	7 Days	14 Days	21 Days
1	CONTROL	0.0091	0.0091	0.0091
2	2 ppm	1.0902	3.6103	4.2138
3	5 ppm	2.3282	4.2595	6.1101
4	10 ppm	4.9161	6.3898	8.9110
5	20 ppm	5.0654	7.6313	10.116
6	30 ppm	14.002	14.151	14.202

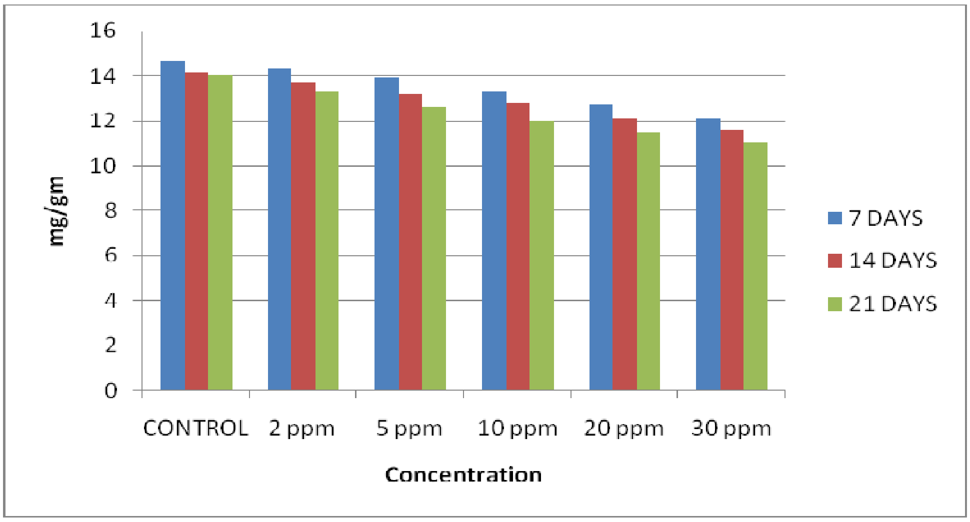

Fig-1: Protein content of accumulated algae of Spirogyra sp.

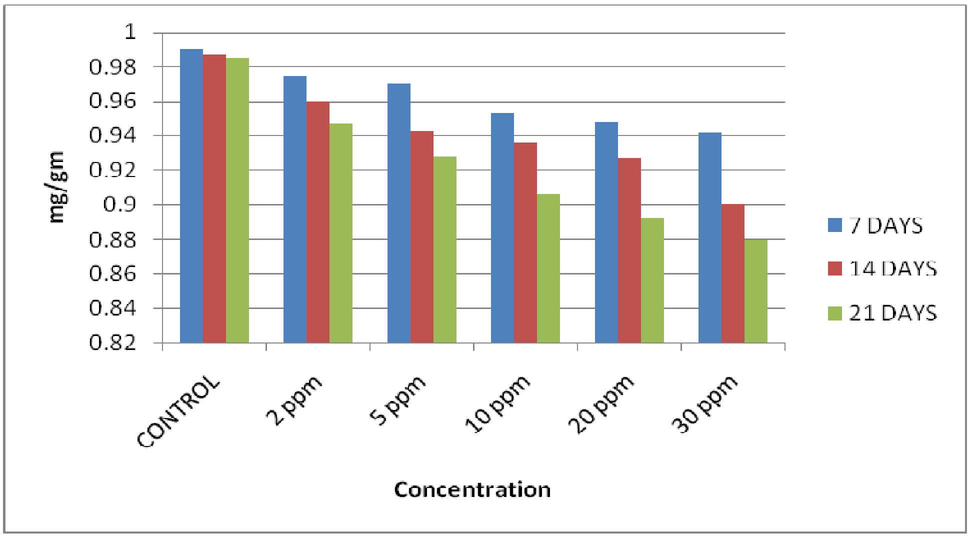

Fig-2: Proline content of accumulated algae of Spirogyra sp.

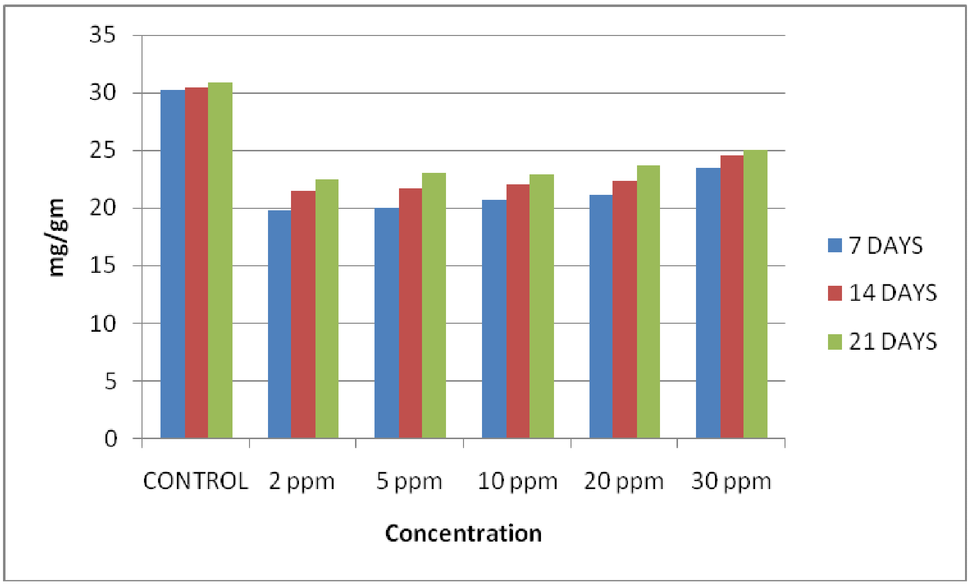

Fig-3: Sugar content of accumulated algae of Spirogyra sp.

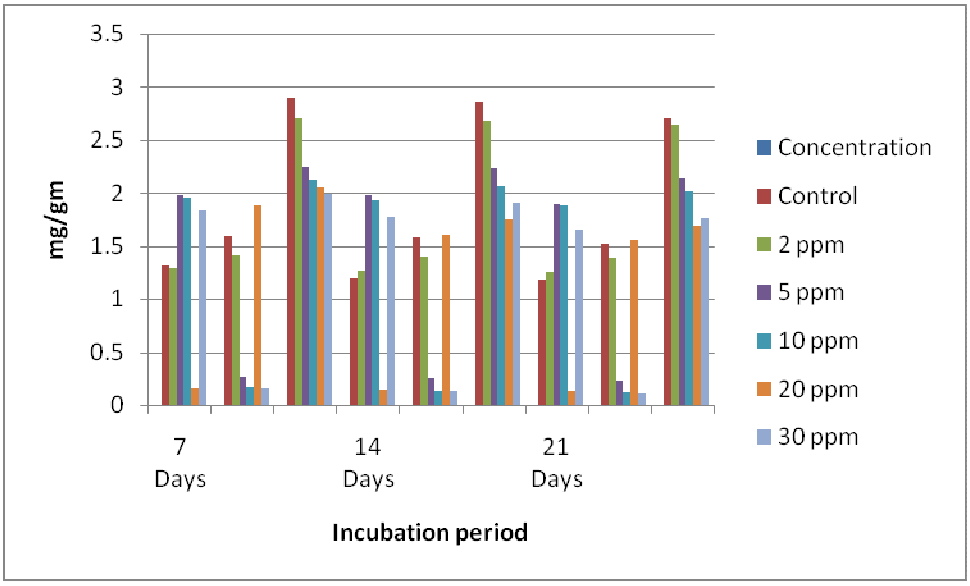

Fig-4: Chlorophyll (chl-a, chl-b and total chl) content of accumulated algae of Spirogyra sp.

CONCLUSION

From this study, it has been shown that Spirogyra sp. can sequester heavy metal of chromium from wastewater, with each alga having different metal concentration factor for specific heavy metals. Therefore Spirogyra sp. act as potential indicators of environmental conditions.

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