Efficiency of immobilized *Saccharomyces cerevisiae* in remediation of Chromum

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SUMMARY

The chromium remediation ability of *Saccharomyces cerevisiae* was studied, as it is non-pathogenic and easily available as wastes from fermentation industries. Normal baker's yeast, mutants and genetic strains with and without metallothioneins were used in their immobilized forms. Their chromium remediating ability was studied and their efficiencies were compared. Flame Atomic Absorption Spectroscopy and diphenyl carbazide method were used to quantify chromium in the effluents. The work also focused on determining whether mutagenesis enhances or lessens the organism's ability to remediate chromium and establishing the role of metallothioneins. The chromium content of the effluent was around 5600ppm before remediation, after which it reduced to around 28ppm. The best activity was observed in the genetic strain containing multiple copies of metallothioneins and the mutants were still efficient in spite of the damage in the *de novo* pathway. Proteins isolated from the strains after bioremediation showed a similar banding pattern to metallothionein suggesting their activity in heavy metal stress.

Key words :
Contamination, Chromium, Remediation, Mutagenesis, Immobilized, Metallothioneins.

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Chromium is the most common pollutant widely used in industries, resulting in the discharge of large quantities into the environment and therefore its contamination is extensive (Bartlett, 1991). Waste water containing chromium are generated by many industries particularly metal finishing industries, petroleum refineries, leather tanneries, iron and steel industries, textile manufacturing industries and others (German and Parrerson, 1974).

In the tanning industry large quantity of chromium or basic chromium sulfate is being used for chrome tanning (Pathe *et al*., 1995). Chrome tanning needs large amount of waste water to reduce residual salts as far as possible, which otherwise causes some problems during finishing of leather products. About 5-6 L of chrome waste water is produced per kg of hide and skin (Prasad and Nair, 1994). Spent chrome tan liquor is acidic in nature and greenish in color. Total suspended solids and BOD ranges were reported to be 1500 to 2400 mg/L and 800 to 3500 mg/L. The permissible limits of Chromium has been fixed at 2.0 mg/L and for industrial effluent discharged into inland surface water and public sewers, respectively.

Chromium is an essential element, required in trace amounts in the diet of some animals and human beings. However, exposure to chromium can damage cell membranes, alter enzyme specificity, disrupt cellular functions and damage the structure of DNA (Bruins *et al*., 2000).

The chromium in the effluents is primarily in the hexavalent form as chromate and dichromate. Hexavalent chromium is highly toxic and carcinogenic (Mearns *et al*., 1976; Nishiota, 1975; Petrilli and DeFlora, 1977; Vennit and Levy, 1974). It activates p53 by reactive oxygen species (ROS) mediated by free radical reactions that occur during the oxidative reduction of hexavalent chromium within the cell. Oxidative damage is considered to be an important mechanism in the genotoxicity of Cr (VI). Because Cr (VI) is a powerful oxidizing agent, exposure can cause irritation and corrosion. When inhaled Cr (VI) is a respiratory tract irritant and causes pulmonary sensitization. Chronic inhalation increases the risk of lung cancer. The other target organs of chromium are the kidneys, liver, skin and the immune system may also be affected. Trivalent chromium also plays a role in the prevention of arteriosclerosis. It stabilizes tertiary structure of proteins and the conformation of the cell RNA and DNA (Zetic *et al*., 2001). However, under certain extreme environmental conditions the trivalent chromium might get oxidized to the hexavalent form. Hence, the need arises to remediate chromium into its harmless form before being discharged.

The treatment of chromium bearing effluent has been reported through several methods such as reduction, precipitation, ion