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Growth Performance of *Staphylococcus* spp. in Chromium Effluent with Various Environmental Conditions

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Microorganisms and microbial products can be highly efficient to bioaccumulations of metals, especially from dilute external solutions. The emerging technologies employing microbes provides as alternative to conventional techniques towards metal removal from diverged ecosystem. Hence in the present study an attempt was made to investigate the growth pattern of metal resistant *Staphylococcus* spp in chromium electroplating effluent with various environmental conditions. Metal resistant *Staphylococcus* spp was isolated from electroplating effluent soil sediments and the strain was confirmed by morphological and biochemical characteristics. Further, the study characterized the growth of *Staphylococcus* spp in chromium containing electroplating effluents with various concentration (15%, 20% & 25%) and with different pH (pH 5, pH 7 & pH 9), and various temperature (20°C, 30°C & 40°C) conditions, the results revealed that *Staphylococcus* spp shown the better growth in 20% chromium containing electroplating effluents with pH 7 at 30°C.

Keywords: Electroplating effluents, Chromium, Biosorption, *Staphylococcus* spp.

Water, the most vital resource of all kinds of life on this planet and it is adversely affected both quantitatively and qualitatively by all kinds of human activities (Trivedi and Goel., 1984). In the wake of industrialization, consequent urbanization and over increasing population, the basic amenities of life viz., air, water and land are being polluted continuously (Shukla *et al*., 2007). Heavy metals include cadmium, lead, chromium, copper and nickel, which contaminate the soils, ground water, sediments and surface waters are extremely toxic to biological and ecological systems. (Alloway, 1995; Diels *et al*., 2002).

Among the heavy metals, Cr (VI) is a very toxic form and more hazardous as it is known to cause many health effects like skin infections or rashes, stomach upset and ulcers, respiratory problems, kidney and liver damage, alteration of genetic damage, lung cancer and may also cause death (Tarannum *et al*., 2012).

Different methods were developed for the removal of heavy metals from wastewater. However efficient and environmental friendly technologies are required to reduce heavy metal concentrations in the effluents (Atkinson *et al*., 1998).

The biosorption method is a promising alternate technology for remediation of contaminated wastewater with various metal contaminants (Hadi *et al*., 2003). Hence the present study focused on growth characterization of *Staphylococcus* spp in chromium effluent.

Materials and Methods

The chromium rich electroplating effluent sample was collected from the direct outlet of Meena Electroplating Industry located at Madurai, Tamil Nadu, India and analyzed for various physicochemical characteristics such as temperature, pH, color, odour, hardness, and electrical conductivity, total suspend solids, total dissolved solids, total solids, sodium, potassium, calcium, biological oxygen demand and chloride from electroplating industrial effluent using standard methods (APHA, 1998). One metal resistant bacterial strain was isolated from electroplating effluent soil sediments and identified by morphological and biochemical characteristics through staining, motility, indole production, methyl red reaction, vogas-praskaur reaction, citrate utilization, catalase reaction, urease production and starch hydrolysis. The test results were compared with Bergey's Manual of Systematic determinative Bacteriology (Bergey's Manual, 1994) for the identification the bacterial isolates. The selected bacterial isolate was further characterized by growing the bacterial isolate in effluent sample with different dilution (15%, 20% & 25%) and with various pH (pH 5, pH 7 & pH 9) and difference temperature (20^{0}C, 30^{0}C & 40^{0}C) conditions. The bacterial growth in medium in the various conditions was analyzed through Spectroscopically (Samarth *et al.*, 2012) at 540 nm and the results were recorded. All the results are statistically analyzed using origin 6.0 software.

Table 1: Physicochemical characteristics of chromium electroplating effluent

S.No	Physicochemical parameters	Results
1.	Temperature (^{0}C)	31±3
2.	pH	6.0±0.5
3.	Color	Yellowish brown
4.	Odor	Unpleasant
5.	Electrical conductivity	11.2±0.818
6.	Total solids (mg/l)	4142±14
7.	Total dissolved solids (mg/l)	2159±11.135
8.	Calcium (mg/l)	8.11±0.465
9.	Sodium(mg/l)	13.77±0.860
10.	Potassium(mg/l)	0.54±0.036
11.	Chloride(mg/l)	3200±9.539
12.	Biological oxygen demand(g/l)	235±5.567
13.	Chemical oxygen demand(mg/l)	4035.22±4.054

Values are mean of three replicates ± standard error

Result and Discussion

Industrial complexes have become the focus of environmental pollution. Industrial operations such as electroplating, steel manufacturing, leather tanning, wood preservation, ceramics, glass manufacturing, and chemical processing and fertilizer applications release alarmingly higher amounts of metals into the natural environment (Zoubolis *et al*., 2004; Khan *et al*., 2009; Oliveria *et al*., 2011 and Tian *et al*., 2012).

The results of physicochemical characteristics in chromium electroplating effluent are presented in Table 1. Metal resistant *Staphylococcus* spp was isolated from effluent soil sediments and identified through morphological characteristics as shown in Table 2.

Table 2: Morphological and biochemical characteristics of *Staphylococcus* spp

S. No	Name of the test	Result
1	Gram's staining	Positive
2	Shape	Cocci
3	Motility	Non Motile
4	Indole	Negative
5	Methyl red	Positive
6	Voges proskauer	Negative
7	Citrate	Positive
8	Catalase	Positive
9	Starch hydrolysis	Positive
10	Gelatin hydrolysis	Positive
11	Urease	Negative

Microbial growth and activity are readily affected by pH, temperature and moisture. Further most of them grow optimally over a narrow range, so that it is important to achieve optimal conditions for microbial growth (Vidali, 2001).

Dadzie *et al*., (2011) have already reported on metal resistant bacterial strain could be used for biosorption studies to remove metal toxicants in various polluted environments. In this study the metal resistant bacteria *Staphylococcus* spp isolated from electroplating effluent soil sediments was characterized for its growth in chromium effluent sample with various pH and temperature conditions (Table 3 and 4). The result reveals that *Staphylococcus* spp grown best in 20% electroplating effluent sample with pH 7 at 30^{0}C. Similar type of work was already done by Mahalingam *et al*., (2014) and they were studied the partial characterization of metal resistant *Bacillus* sp. isolated from electroplating effluent sediments which showed the better growth in pH 7 and 30°C.

Table 3: Growth of *Staphylococcus* spp in different concentrations of Chromium electroplating effluent medium with various pH on 24 hours

S.No	pH	OD value at 540 nm		
		15%	20%	25%
1.	5	0.352± 0.009	0.806± 0.004	0.504± 0.011
2.	7	0.768± 0.018	1.47± 0.075	0.888± 0.009
3.	9	0.643± 0.005	0.681± 0.008	0.779± 0.007

Values are mean of three replicates ± standard error

Table 4: Growth of *Staphylococcus* spp in different concentrations of Chromium electroplating effluent medium with various temperature on 24 hours

S.No	Temperature	OD value at 540 nm		
		15%	20%	25%
1.	20^{o}C	0.342± 0.015	0.586± 0.008	0.392± 0.004
2.	30^{o}C	0.422± 0.003	0.779± 0.005	0.681± 0.003
3.	40^{o}C	0.352± 0.004	0.434± 0.003	0.391± 0.006

Values are mean of three replicates ± standard error

Conclusion

The study on identification of microbes for resistance against different metals may provide a useful tool for the simultaneous monitoring of several toxic pollutants in the environment. The *Staphylococcus* spp isolated in this study could tolerate to grow in chromium electroplating effluent medium. Hence, this species could be used effectively in biosorption studies.

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