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Biosorption of Chromium Ions by *Streptomyces mutabilis* Isolated from Industrial Wastewater Treatment Plant

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ABSTRACT

The removal of heavy metals by actinomycetes has been the subject of many investigations as they are used as potential heavy metal sorbents. This study aimed to evaluate chromium biosorption activity of some actinomycetes isolated from wastewater sample collected from Industrial Wastewater Treatment Plant (IWWTP), Jeddah, Saudi Arabia. About 35 different isolates of actinomycetes were obtained on starch nitrate medium with 100 ppm of chromium ions. The removal of chromium from growth medium was maximum by isolate FM2 which was selected and identified as a species belonging to the genus *Streptomyces*. The 16S rRNA sequence of this isolate showed the highest similarity (98%) with *Streptomyces mutabilis* and identified as *S. mutabilis* FM2. The growth of the previous isolates was determined after 5 days at 30 ^{0}C in the presence of different chromium oxide concentrations, 50- 300 mg/l. The minimum inhibitory concentration (MIC) of this isolate for Cr (VI) was 135 mg/l. By dead biomass of the previous isolate FM2 (1g/l), the biosorption capacity measured by Plasma Atomic Emission Spectrometer ICPE-9000 of the bacterial strain for Cr (VI) ion was 800 mg/l which was 38% of the initial metal ion concentration. The maximum biosorption process for the tested isolate was recorded at pH 7, optimum temperature at 45 ^{0}C. Biosorbent mass of 0 – 1.5 g was tested for removal of chromium. The result showed that the adsorption capacities against the heavy metal Cr (VI) were increased with increasing the weight of the used dry biomass. The genus *Streptomyces* was the most potent in removing of heavy metals and *S. mutabilis* biomass has a good potential to be used in removal of chromium from wastewater. Their use in real life situation can alleviate pollution and increase the quality of water for human consumption and sanitary purposes. Initial concentration of metal ion, pH and cell biomass affect chromium biosorption process by the dried cells of *Streptomyces mutabilis*.

KEY WORDS: BIOSORPTION. MTC, BIOMASS, STREPTOMYCES MUTABILIS, BIOMASS, WASTEWATER, BIOREMEDIATION.

INTRODUCTION

One of the growing problem over the world is water pollution by chemical specially with heavy metals which showed serious side effects on human health and its environment. Several metals were highly toxic at low concentrations and through food chains, they accumulated in liver, kidney and other humans and animal tissues (Singh et al., 2011, Sahmoune, 2016). Physical or chemical methods like activated carbon adsorption, ion exchange, membrane filtration, and chemical precipitation can be applied to remove heavy metals from wastewater (Wang and Chen, 2009, Lakherwal, 2014). Nanocomposites adsorbents were applied to the removal of heavy metals from aqueous solution (Lu et al., 2017). Ion imprinted polymers has been used for elimination of heavy metal ions at low concentrations in complicated matrices (Cai et al., 2013, Fu et al., 2016). Heavy metals bioremediation methods received increasing attention because they are more safe and easily to be applied (Saiano et al., 2005, Yin et al., 2016).

Through the past two decades, biosorption method is efficient technique, cost effective and alternative for water and wastewater treatments (Ahmad et al., 2018). Biosorption methods were briefly studied by many authors

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(Al-Homaidan et al., 2014, Vendruscolo et al., 2017, Abed et al., 2020). Biosorption is a physicochemical process which involves the removal of various pollutants, such as heavy metals from solution by biological materials (Fadel et al., 2017, Yang and Wang, 2009). Different types of microorganisms, such as bacteria, algae, fungi and yeast cells can remove heavy metals from aqueous solutions (Vijayaraghavan and Balasubramanian, 2015, Podder and Majumder, 2016). The removal rate of Cr^{6+} has been explored by the optimized removal conditions by *Bacillus subtilis* strain SZMC 6179J and the initial pH, initial Cr^{6+} concentration (mg/l), time (hrs) and inoculation percentage (%) affect removal process. The optimal conditions for removal by the previous isolate were at pH 5.0, incubation time 24.0 hrs, inoculation percentage 4.6% (v/v) and initial concentration of Cr^{6+} 55.0 mg/l (Liu et al., 2020).

Actinomycetes, particularly *Streptomyces* species have been tested for uptake metals with very encouraging results (Gupta et al., 2015). *Streptomyces* species are stable and are not subject to the drastic treatments, and possess advantages such as low investment cost, and high treatment efficiencies (Mosbah and Sahmoune, 2013). Among the actinomycetes, the genus *Streptomyces* have produced useful secondary metabolites and the major source of a new bioactive molecule and good antibiotic producing organisms (Takahashi and Omura, 2003). *Streptomyces* are gram-positive filamentous bacteria with high guanine/cytosine content. *Streptomyces* strains characterized by a complex life cycle and the production of an amount of secondary metabolites which often find a use in medicinal applications (Hopwood, 2006). Streptomyces cells have excellent role in heavy metal removals and degradation of different pollutions. The aim of this study is to investigate the use of *Streptomyces mutabilis* biomass as an adsorbent for removing heavy metals from industrial wastewater solutions such as chromium which could reach to the underground water, causing harmful effects on human, animals, and plants.

MATERIAL AND METHODS

Collection of Soil Samples: For the present investigation, soil samples were collected from different contaminated soil area and were used for Actinomycete isolation. All samples were collected from Industrial Wastewater Treatment Plant located in Jeddah. Each sample was collected in sterile test tubes and stored at 4°C until used.

Isolation and Purification of Chromium Resistance Bacterial Isolate: About one gram of each soil samples was suspended in 9 ml of sterilized distilled water and serial dilution was done. One ml of each dilution was separately added to the surface of a plate containing starch nitrate agar medium and incubated at 30°C for 5 days. The obtained bacteria colonies were transferred to new plates until obtained of pure colonies which purified by streaking on soiled agar medium. The selected bacterial colonies were purified and transferred to slants on Starch nitrate agar for preservation at 4 ^{0}C. Long preservation of strains was in starch broth plus 50% sterile glycerol and stored at -20^{0}C until used (Ramesh and Mathivanan, 2009, Kannabiran, 2010).

Morphological, physiological and biochemical characterization of the bacterial isolates: Contaminated soil samples from Industrial Wastewater Treatment Plant, located in Jeddah, were used for actinomycetes isolation on Starch nitrate agar medium as described by Bakan et al., (2019). All actinomycete isolates were screened for Chromium resistant activity on starch nitrate agar medium containing 100 mg/l . After 5 days at 30 ^{0}C, the most resistance isolates were screened on medium contained different concentrations of Cr(VI) and minimum inhibitory concentration (MIC) was determined (Bakan et al., 2019). Strain FM2, the most resistant isolate, was preliminarily identified according to traditional morphological criteria, including morphology and growth pattern on starch nitrate agar.

Characteristics of the bacterial colonies on the agar plate, morphology of substrate and aerial hyphae, the morphology of spores, color of the produced pigment were carried out (Shirling and Gottileb, 1966). Also, the selected bacterial isolate FM2 was cultivated on different media plates for example; Yeast extract -malt extract agar (ISP-2), In-organic salts-starch iron agar (ISP-4), and Tyrosine agar (ISP-7) plates and identified according to morphology, physiology and biochemical characters. The cellular morphology of the bacterial isolate FM2 was examined under light microscope. Moreover, biochemical characterization of the isolate was carried out as described in International actinomycetes isolates Project including biochemical identification tests such as catalase, citrate oxidase, indole production and sensitivity to antibiotics (Pridham and Lyons, 1961).

Molecular Identification: Genomic DNA from each isolate was obtained using the QIAamp DNA Mini Kit (Weisburg et al., 1991). Then, the concentration and purity of DNA were determined. In princess Al-Jawhara Center of Excellence in Research of Hereditary Disorders, the 16S rDNA gene was amplified by PCR using the forward primer 5'-AGTTTGATCATGGTCAG-3' and the reverse primer 5'-GGTTACCTTGTTACGACT-3'. The DNA sequence was compared to the GenBank database at the National Center for Biotechnology Information (NCBI) using the BLAST program (Saitou and Nei, 1987).

Study of the Minimal Inhibitory Concentrations: The actinobacteria isolate FM2 was screened for heavy metal-resistant activity in starch nitrate agar medium, after preparing of the medium it was sterilized by autoclaving at 121°C for 15 min, then different concentration of each sterile metal salt solution was added a to molten cooled starch nitrate agar medium immediately before pouring to the plates and solidification. Microbial growth was used as the qualitative parameter of mean resistance after seven days of incubation at 30°C. Testing for tolerance of the microorganisms ended when complete inhibition of the growth was observed on the nutrient agar with metal

supplementation (Koushalshahi et al., 2012, Daboor et al., 2014). This method was used to determine the minimum inhibitory concentration (MIC) for each concentration of the heavy heavy metal at which there is no colony growth in the three copies. This method was used to give a rapid screening, but it is a qualitative estimation (Abbas and Edwards, 1989).

Biomass preparation of actinobacteria for biosorbent process: The biomass of actinobacteria (biosorbent) was prepared by the method of Saurav and Kannabiran (2011b), (Latha et al., 2015). The tested isolate FM2 was cultivated in 500 ml flasks containing 100 ml of starch nitrite broth medium and was kept shaking in an orbital rotary shaker at 130 rpm for 10 days at 30 ⁰C. Then, the cultures were harvested by centrifugation at 4500 rpm for 15 min and were washed three times with distilled water. The pellet was kept in glass petri dishes and dried at 70 ⁰C for 24 h. After the biomass was dried, it was crushed in a blender to powder. Then, it was used for further studies.

Preparation of Metal Solutions: The heavy metal used for the screening of metal resistance in actinobacterial isolate was chromium (Cr). The salt solution was prepared from analytical-grade Chromium (VI) oxide, sterilized separately for 15 min at 110°C (Saurav and Kannabiran, 2009) and preserved at 4^0 C until used. The concentrations of metal ion were prepared from stock solutions of 100,000 mg/l. Fresh dilutions were used for each study. The pH of each test solution was adjusted to the required value by using 1 M NaOH and 1N HCl (Latha et al., 2015).

Biosorption Experiments: The chromium removal ability of the actinomycete isolate FM2 was determined by measuring the level of chromium uptake following the method of Saurav and Kannabiran (2011b) with slight modifications. The isolated strain was tested to biosorption of Cr (VI) metal salt solution at different concentrations (50–300 mg/l) then in different concentrations (0.5, 1.0, 2.0, 2.5, 3.0 g/l of biomass obtained from tested strain. The dried biomass of the actinomycete isolate was suspended and the pH was adjusted to 7.0. Then the flasks were kept shaking in an orbital rotary shaker at 130 rpm for one week after that the filtrates were analyzed for chromium concentration by Plasma Atomic Emission Spectrometer ICPE-9000. The metal removal efficiency (MRE) was calculated by using the following equation.

$$\% \text{ of MRE or } \% \text{ Biosorption} = C_i - C_f / C_i \times 100$$

Where MRE: metal removal efficiency, C_i represents the initial chromium metal ion and C_f represents the final chromium metal ion concentration.

Effect of pH and temperature on Heavy Metal Removal: The dry biomass (0.25 g) of the Actinomycete isolate FM2 was incubated into a series of 100 ml conical flasks containing either 25 ml of distilled water with 320 mg/l of chromium (VI) oxide. The pH was varied from 4 to 10 (4, 6, 7, 8 and 10). On the other hand, the effect of different temperatures (24, 28, 30, 35 and 45 ⁰C) on biosorption capacity was detected. The pH of the medium was adjusted using dilute HCl or NaOH. Then, all flaks were incubated at 30 ⁰C and 130 rpm for 5 days. The percentage biosorption of metal ions was calculated at the all tested pH values.

Concentration of Heavy Metals Residuals in the Bacterial Biomass: To detect the residual of chromium found in the biomass of the isolate which they involved in bioremediation technique, the biomass fragments were collected after centrifugation at 4500 rpm in 15 minutes. then the samples pallets were collected and oven-dried at 70 ⁰C about 24 h. After that, each sample (0.5 g) was then digested through addition of 5 ml of hydrochloric (HCl) acid and 5 ml sulphuric acid (H2SO4). After heating gently until the samples were digested (formation of a clear solution above the residue), the volume was adjusted to 10 ml with distilled water, pH was adjusted to 7 with 5 M NaOH and the solutions were analyzed for metals concentrations Cr (VI) using Plasma Atomic Emission Spectrometer (ICPE-9000).

Applied Biosorption Experiments: This experiment was detect the ability of dead bacterial biomass FM2 to removal heavy metal Cr(VI) from industrial wastewater. At first, the content of different heavy metals of waste water was analysis of by Plasma Atomic Emission Spectrometer ICPE-9000. Then, two conical flask (250 ml) containing 100 ml of waste water from Bani Malek Station, with 0.5 g of dry dead bacterial biomass, obtained from tested, was kept shaking at 130 rpm for one week at 3^0 C. After that the content of each flask was filtered through filter paper and the filtrate was analyzed for metal concentration by Plasma Atomic Emission Spectrometer ICPE-9000. The percentage biosorption of metal ions was calculated as follows:

$$\% \text{ of MRE} = C_i - C_f / C_i \times 100$$

RESULTS AND DISCUSSION

The actinobacteria with potential heavy metal biosorption ability were selected for identification. The morphological, culture and biochemical characteristics of the strains were investigated and recorded in Table 1. The isolate FM2 was Gram positive, not acid fast, with non-motile cells and substrate and aerial mycelia were well developed. The color of the isolate, on starch nitrate was gray. The growth on solid medium and examination under light microscope were recorded (Table 2, Figure 1). The growth and shapes on different agar media were appeared in Table 3 and Figure 2. The isolate FM2 grow well on starch nitrate agar, In-organic salt starch iron agar ISP4, and tyrosine agar was recorded on ISP-7, while moderate growth on yeast extract malt extract agar (ISP-2), E-Medium (ISP-9), Glycerol asparagine agar (ISP-5), and dextrose agar.

Table 1. The selected actinomycetes, color, growth, mycelia and production of melanin pigment

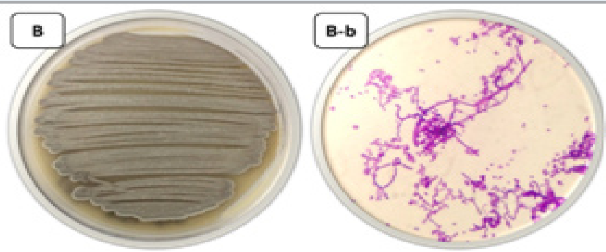
Isolates	Color	Growth (100 ppm Cr)		Substrate and aerial mycelia	Melanin pigment
		On agar medium	Dry weight g/l		
FM1	Pink	+	0.17±0.01	Well developed	+ve
FM2	Gray	+++	0.37±0.02	Well developed	+ve
FM4	Black	++	0.30±0.02	Well developed	+ve
FM9	Pink	++	0.23±0.02	Well developed	-ve
FM11	Gray	++	0.30±0.09	Well developed	-ve
FM15	White	++	0.21±0.01	Well developed	-ve

+: Poor growth, ++: Moderate growth, +++: Good growth, -ve: No pigment, +ve: Detected pigment

Table 2. Morphological characteristics of the selected isolate FM2

Characteristics	Results	Characteristics	Results
Gram stain	Gram-positive	Aerial mycelium	Present
Colony size	Discrete	Sporangia	Absent
Acid fast stain	Negative	Optimum temperature	30 °C
Motility	Absent	Optimum pH range	6.5 - 8.0
Respiration	Aerobic	Melanin pigment	Positive
Substrate Mycelium	Branched	Catalase	Positive
Spore chain	Positive	Penicillin	Sensitive
Motile spores	Absent	Cephalosporin	Resistance

Figure 1: The selected actinomycete isolate FM2, B: grown on starch nitrate agar medium, B-b: under light microscope x1000.



On the other hand, the isolate FM2 use different carbon and nitrogen sources, it was found that it used strongly the carbon sources, glucose, sucrose, lactose, and maltose while moderate utilization was recorded by isolate FM2 for starch, dextrose and fructose. Moreover, different nitrogen sources, yeast extract and peptone were well utilized by isolate FM2 table 4.

Molecular Identification: The selected strain shown the partial sequencing of 16S rRNA gene of the strain on both directions yielded 16S rDNA nucleotide sequence length with 1300 base pairs. The BLAST search of 16S rDNA sequence of the strain showed the highest (98%) similarity with *Streptomyces mutabilis* strain 64-LR13-2, *Streptomyces mutabilis* strain (HVA-18), and *Streptomyces* sp. Strain EL060 (Figure 3).

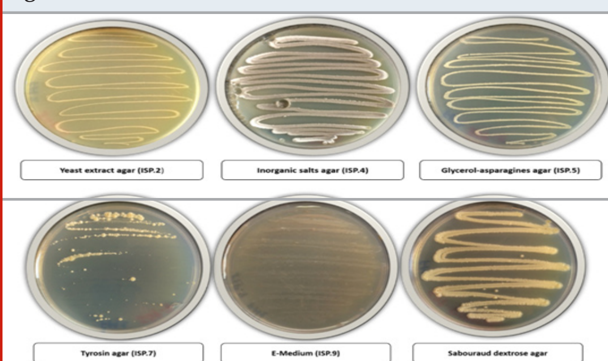
Minimum Inhibitory Concentration (MIC) of Chromium: In this study, the actinomycetes isolate from soil were explored for their bioremediation capabilities to prove that they have potential in bringing down the intensity of heavy metals in media. The inhibitory effects of Cr (VI) on bacterial growth were investigated on starch nitrate agar medium. The MIC was 135 mg/l for Cr (VI) as shown in Figure 4 and Table 5. Percentages of chromium adsorption by FM2 cells (0.1 g/l) added to different concentrations of chromium were determined. At 50 mg/l Cr, the removal percentage was 100% and decreased by increasing Cr concentrations (Figure 5). The percentage of adsorption was a function of the initial metal concentration. The amounts of metal uptake q (mg/g) by the dead biomass of FM2 at a different metal concentration Cr (VI) are calculated. Table 6 showed the amounts of chromium uptake q (mg/g) by the different concentrations of the dead biomass of isolate FM2. The amounts of metal uptake q (mg/g) by the dead biomass of isolate FM2 was ranged from 23.24% to 5.00% with a maximum adsorption of 34.86 % using 0.12 mg/l of the dry mass.

As the biosorbent weight of the tested isolate was increased from 0.12 to 1.50 g, the removal percentage increased from 34.86% to 93.91% for Cr (VI) but the chromium uptake q (mg/g) was decreased.

Table 3. Growth of FM2 isolate on different media growth for 5 days at 30°C.

Media	Growth	Color of aerial mycelium	Color of substrate mycelium	Soluble pigment
Starch Nitrate	Heavy	Grey	Grey	Light grey
Yeast extract-malt extract (ISP-2)	Moderate	Creamy	Creamy	Light brown
In-organic salt-starchiron (ISP4)	Heavy	Dark grey	Grey	Creamy
Glycerol asparagine (ISP-5)	Moderate	White	White	No- pigment
Tyrosine medium (ISP-7)	Heavy	Light grey	Light grey	No- pigment
E-Medium (ISP-9)	Moderate	Page	Page	No- pigment
Dextrose Sabouraud	Moderate	Creamy	Creamy	Yellow pigment

Figure 2: Growth of bacterial isolate FM2 on different agar media



The results showed the effect of pH on the adsorption of chromium oxide by dead biomass of the tested isolate. The highest biosorption capacity for chromium was at pH7 (Figure 6). Figure 7. showed the effect of different temperatures on the adsorption of chromium by the dead biomass of the tested isolate FM2. Biosorption capacity was analyzed over a temperature range from 24^{0} C to 45^{0} C. The highest biosorption capacity of chromium by the tested isolate was 100% at 37-45^{0} C. Wastewater was collected from wastewater treatment plant and the selected bacterial isolate was used for chromium removal from wastewater. At the beginning the Chromium concentrations was 11 mg/l. After 7 days of incubation with the tested bacteria, the concentration of chromium decreased to 0.0 (as shown in Table 7).

Table 4. Growth of bacterial isolate FM2 on different carbon and nitrogen sources

Carbon sources	Glucose	Sucrose	Starch	Lactose	Dextrose	Maltose	Fructose
Results	+ + +	+ + +	+ +	+ + +	+ +	+ + +	+ +
Nitrogensource	Ammonium sulfate	Ammonium chloride	Sodium Nitrate	Potassium nitrate	Glycine Peptone	Vanillin	
Results	±	+	+	+	+ +	+	

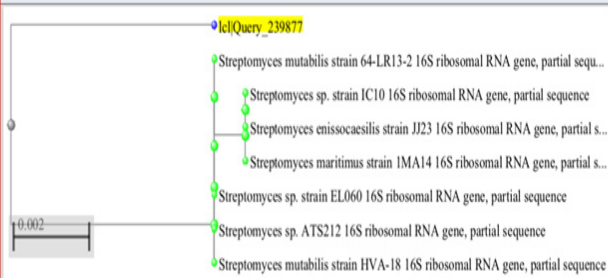
+++: high utilization, ++: moderate utilization, +: weak utilization, ±: very weak utilization

In Saudi Arabia, Jeddah is one of the biggest cities with about three million inhabitants. Large quantities of wastewater returned to the environment and accumulated in underground pools. Only 30 percent went wastewater treatment plants for purification before being dumped in the Red Sea. Most of the wastewater that is accumulated through pipes must be treated for heavy metal removal before dumping into the sea. Without purification, wastewater caused massive damage to the aquatic animals, beaches, air, human health and soil. Sewage treatment plants facilitate and improved wastewater management. The heavy metals such as Fe^{++}, Cu^{++}, Zn^{++}, Ni^{++}, Mn^{++}, Cd^{++}, Pb^{++} and Cr^{+++} are toxic pollutants of the environment, wastewater and aquatic live (Amundsen et al., 1997; Wong et al., 2001). Accumulation of these metals in soil, animal tissue is documented (Li et al., 2006, Okoye et al. 2011, Abduljaleel et al., 2012).

Thus, in recent decades removal of heavy metals using conventional physical and chemical methods are urgent but these methods are high expensive, low effectiveness and non eco-friendly. Biosorption methods by biological materials like live or dead microbes of non-pathogenic bacteria, fungi, gut microflora and actinomycetes can be used to remove detoxify and eliminate some heavy metals from soil and solutions. These methods are effective, little price, eco-friendly. easy to applied and had beneficial health effects (Wang and Chen, 2009). In different ways, actinomycetes played an important role in removal of harmful metals. Thus, in this study we tried to isolate and

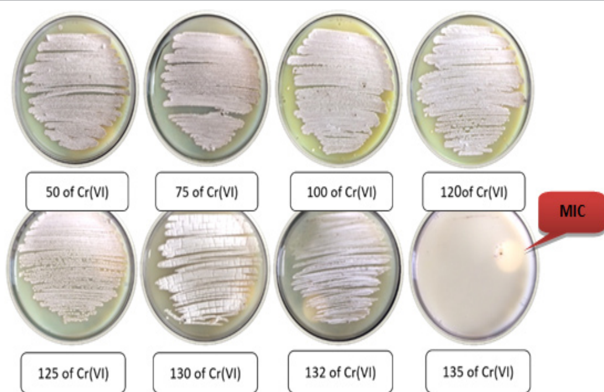
identify some actinomycete genera from contaminated area that can remove Chromium ions which showed high toxicity to living cells and pollute human environments (water, food, air and soils). Two forms of Chromium are recorded, trivalent (Cr III) which is less toxic to plants and animals and hexavalent (CrVI) which cause human cancer, genotoxicity, acute and chronic toxicity to skin and nervous and immune systems in addition to general environmental toxicity (Bagchi et al., 2002).

Figure 3: Phylogenetic tree based on 16S rRNA for *Streptomyces mutabilis* FM2.



As was reported before, actinomycetes showed exceptional resistance properties to some heavy metals and they adaptive themselves to adsorb these metals during continuous exposure (Abbas and Edwards 1989; Amoroso et al. 2000). Koushalshahi et al. (2012) reported that actinomycetes from contaminated samples are resistant to heavy metals compared to those from non-contaminated area. On minimal agar medium, out of

Figure 4: Effect of different concentration of chromium (50-135mg/l) on growth to the isolate FM2.



15 isolates, isolate FM2 was the most tolerant isolate (MIC value 135 mg/l). Latha et al., (2015) reported that the MIC was in the ranged from of <50–250 mg/l. It was identified as species belong to genus *Streptomyces* according to morphological, physiological, and biochemical characteristics. Identification was confirmed using molecular method. 16S rRNA sequence analysis is a tool used for confirmation of the identification of bacteria (Wallhausser et al., 1964, Muharram et al., 2013). Using 16Sr RNA, The isolate FM2 was identified as *Streptomyces mutabilis* FM2. The previous method was used by many authors (Dhanasekaran et al., 2012; Saha et al., 2013, Bahamdain et al., 2020, Aly et al., 2020).

Table 5. Actinomycetes isolates tolerance to different chromium concentrations.

Cr (VI) (mg/l)	50	70	100	115	125	120	125	130	135	150
FM 2	++ +	++ +	+ ++	+ ++	+ +	+ +	++	+	+	-

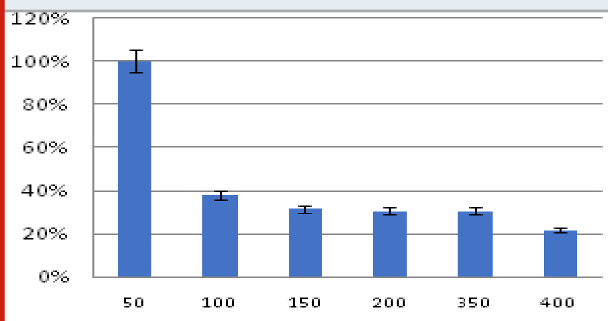
+++: high growth, ++: moderate growth, +: Low growth,-: no growth

Table 5. Effect of different concentrations of biomass on Chromium (VI)removal from a solution at 320 mg/l.

Biomass weight (g/l)	Final chromium concentration (mg/l)	% Biosorption	Specific metal uptake (mg/g)
0.00	320	0.00	0.00
0.12	208.41	34.86	23.24
0.25	172.91	45.96	14.70
0.50	77.90	75.65	12.10
0.75	64.65	79.79	8.51
1.00	51.25	83.98	6.71
1.50	19.48	93.91	5.00

* Specific metal uptake (Q)

Figure 6: Capacity of chromium adsorption by FM2 isolate(0.1 g/l) on different concentrations of chromium.



The biosorption capacity of *Streptomyces mutabilis* for Cr(VI) was found to be maximum (100%) at 50 mg/l metal ion concentration using 0.1 g/l of the cell biomass. At pH 7.0 at 37- 45^0 C, the higher biosorption ability (100%) was obtained using 0.12 mg/l of the dry material.

Increasing the concentration of Cr(VI) decreased biosorption capacity which may due to metal saturation on biosorption material while increasing the weight of the biosorption material, increased the biosorption capacity due to the highest contact between bacterial cell wall and metal ions (Saurav and Kannabiran, 2011a,b). They added that maximum Cr(VI) biosorption by *Streptomyces* sp. dry cells (3 g/l) was obtained at 100 mg/l at pH 7.

Figure 6: Effect of different pH rage on biosorption of Cr(VI) at 50 mg/l by dried cell of bacterial isolate FM2 (0.12 mg/l).

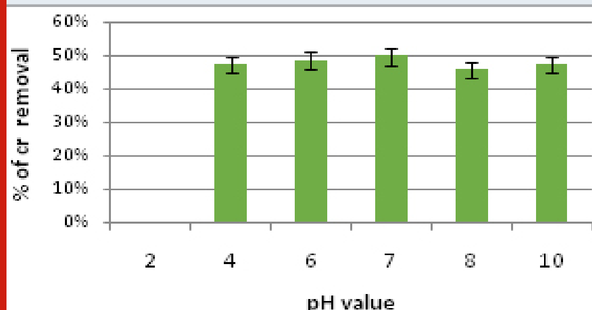


Figure 7: Effect of different temperatures on the biosorption of chromium at 50 mg/l by dried cells of bacterial isolates FM2(0.12 mg/l).

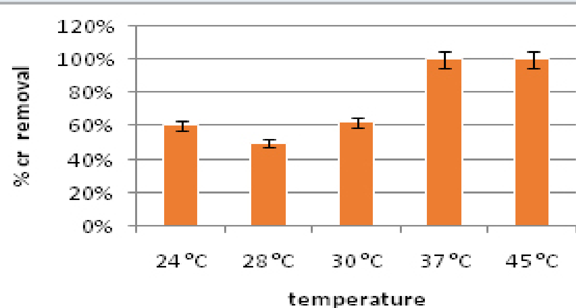


Table 6. Biosorption of some heavy metals from waste water using dry biomass of the isolate FM2.

Isolate	Chromium (VI) Concentration		
	At the start (mg/l)	After 7 days (mg/l)	% of Biosorption
FM2	11±0.7	0.00	100 %

Biosorption or removal capacity of heavy metal was affected by biosorbent weight, pH and initial metal concentration (Donmez et al. 1999, Yao et al. 2009, Saurav and Kannabiran 2011b) Cr(VI) ions react with several functional groups like the hydroxyl (OH), amine (NH2) and carboxyl (CO) groups, found on the bacterial biomass which play an important role in the metal ions biosorption process. Microbial cell walls contained, peptidoglycan polysaccharide, glycoprotein, glucan, chitin, mannan, phosphomannan and teichoic and teichuronic acids which may adsorb metal ions (Volesky 1990). The potent Cr(VI) biosorbent *Streptomyces mutabilis* was used to purify wastewater from heavy metals and to control the problem of bioaccumulation in living cells. Bakran et al. (2019) used two *Streptomyces* to remove lead from wastewater. In conclusion, *Streptomyces mutabilis* belong to actinomycetes and showed excellent activity to remove and resist hazardous heavy metals like Cr(VI) with maximum biosorption (100 %) at 0.12 g/l at pH7 and 37-45 °C after 7 days.

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