Electronic Journal of University of Aden for Basic and Applied Sciences
EJUA-BA Vol. 4 No. 4 (2023)
https://doi.org/10.47372/ejua-ba.2023.4.304
ISSN: 2708-0684

RESEARCH ARTICLE

# REDUCTION RATE OF SOME HEAVY METAL IN DIFFERENT CONCENTRATIONS USING *Pseudomonas aeruginosa* ISOLATED FROM TENNARY WASTEWATER EFFLEUNT

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**Received: 15 November 2023 / Accepted: 02 December 2023 / Published online: 31 December 2023**

## Abstract

Industrial developments led to environmental pollution with toxic heavy metals which spreading all over the world. Heavy metal pollution, characterized by its heightened toxicity, resistance to biodegradation, and biological accumulation, has significantly jeopardized both human health and ecological stability. Microbial activities offer a potential avenue for immobilizing, removing, and detoxifying active heavy metal ions in the natural environment. This research aimed to study the ability of *Pseudomonas aeruginosa* in reducing the amount of Cd, Ni, Cr, Zn and Pb that found in tannery wastewater and to investigate its survivability in high concentrations of these metals. In this study *Pseudomonas aeruginosa*, was isolated from tannery effluents wastewater. *Pseudomonas aeruginosa* has been incubated in medium contained 50, 100, 300, 500 and 1000 ppm of Cd, Ni, Cr, Zn and Pb for 6, 12 and 24hrs at 37 °C. Results showed that *Pseudomonas aeruginosa* was able to cause a significant reduction of Cd, Ni, Cr, Zn and Pb at incubation time of 24 hours at concentration of 50, 100 and 300 ppm ,the reduction level for Ni were (96.5%, 96.2% and 96.4 %) respectively, Cd (76.4%, 82.1% and 83.8 % )respectively, Cr showed reduction rates of ( 97.7% , 99.4% and 99.1%) respectively, Pb ( 87.3% ,91.9% and 89.6%) respectively, and (82%, 87.6% and 80.1 %) respectively for Zn, *Pseudomonas aeruginosa* was not able to grow at concentration level of 500 and 1000 ppm for Cd, Ni, Cr, Zn and Pb. These results indicated that *Pseudomonas aeruginosa* is able to survive in tannery effluents wastewater containing high levels of Cd, Ni, Zn, Cr and Pb. Therefore, more research is recommended to study the ability of this species to remove Cd, Ni, Cr, Zn and Pb in different conditions.

**Keywords:** *Pseudomonas aeruginosa*, Bioremediation of heavy metal, Heavy metal resistant bacteria, Absorption.

## Highlights:

- The survival capabilities of Pseudomonas aeruginosa in high concentrations of Cadmium (Cd), Nickel (Ni), Chromium (Cr), Zinc (Zn), and Lead (Pb)
- Significant Reduction of Ni (96.5%), Cd (83.8%), Cr (99.4%), Zn (87.6%) and Pb (91.9%) for 24hrs incubation time.
- High concentrations of heavy metals might Cause to decay of Pseudomonas aeruginosa

## 1. Introduction

Nowadays, the word ‘heavy metal’ has been used to describe metallic chemical elements and metalloids which are toxic to the environment and humans, they are defined as heavy metals either due to their high atomic weight or because of their high density [1-4]. Uncontrolled urbanization has led to pronounced contamination concerns due to the disposal of wastewater and modern effluents to water bodies. This industrial effluent contains high levels of heavy metals that may pollute the environment once it is discharged to the nature. Heavy metal contamination is a growing concern in the developing world. Wastewater treatment coupled with increased industrial activity, have led to increased heavy metal contamination in rivers, lakes, and other water sources in developing countries. However, common methods for removing heavy metals from water sources, including membrane filtration, activated carbon adsorption, and electrocoagulation, are not feasible for developing countries. As a result, a significant amount of research has been conducted on low-cost adsorbents to evaluate their ability to remove heavy metals [5]. Due to their non-biodegradable characteristics, heavy metals tend to persist in nature, leading to bio-accumulation in food chain which causes severe environmental and health issues. These heavy metals and their compounds, even at very low concentrations, are highly toxic, carcinogenic, mutagenic and teratogenic. Direct contact, inhalation and ingestion of these heavy metals poses serious threats to human physical and mental health causing mutations and genetic damage, damaging central nervous system as well as escalating the risk of cancers [6]. These toxic heavy metals in wastewater effluents is crucial to remediate before discharging them. Hence, metals include: arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), mercury (Hg), silver (Ag), zinc (Zn) and others[7]. Cadmium (Cd), lead (Pb), copper (Cu), and zinc (Zn) cause an alarming combination of environmental and health problems [8], [9]. Number of microbial species like bacteria, yeast and algae are known to be capable of adsorbing heavy metals on their surfaces as well as aggregating inside their structure [10]. Biological removal (using Bacteria) of heavy metal contaminant from aquatic effluents offers extraordinary potential when metals are available in follow trace amounts. A number of mechanisms by which microorganism's tolerance and remove heavy metal have been proposed, most of them are not efficient for total elimination of toxic metal ions or organic matter [11, 12]. Bioremediation is a cost-effective and practical solution for removing environmental contaminants [13]. Bioremediation uses primarily microorganisms or microbial processes to degrade and transform environmental contaminants into harmless or less toxic forms [14], Most of the techniques in bioremediation are aerobic in nature, but anaerobic processes are also being developed to help in degradation of pollutants in oxygen deficit areas [15]. Bioremediation of heavy metal by bacterial cell has been recognized as potential alternative to existing technologies for the removal of heavy metal from the industrial waste. Microorganisms cooperate with metal particles through cell wall related metals, intracellular aggregation, metals iderophore, extracellular polymeric responses with change, extracellular preparation or immobilization of metal particles, and volatilization of metals [16].Metals and metalloids are appended to these ligands on cell surfaces, which uproot fundamental metals from their ordinary restricting destinations. When the metal and metalloid are bound, microbial cells can change them starting with one oxidation state then onto the next, subsequently decreasing their poisonousness [17]. The mechanisms by which metal ions bind to the bacterial and fungal cell surface include covalent bonding, electrostatic interactions, extracellular precipitation, redox interactions, Van der Waals forces or the combination of these processes [18, 19]. *Pseudomonas aeruginosa* found very effectively in bioremediation of heavy metal because metals are directly and indirectly involved in the all aspect of microbial growth metabolism.

The purpose of this study was to examine the patterns and rates of uptake of Cadmium (Cd), Nickel (Ni), chrome (Cr), Zinc (Zn) and Lead (Pb) by using *P-aeruginosa* under supportive growth and nonsupportive growth conditions and to evaluate the rule of *Pseudomonas aeruginosa* isolated from tannery effluent to reduce the amount of Cadmium (Cd), Nickel (Ni), chrome (Cr), Zinc (Zn) and Lead (Pb) from wastewater and to investigate its ability to survival in contaminated wastewater contain high concentrations of heavy metals.

## 2. Materials and Methods

### 2.1. Sample collection:

A pre-sterilized glass bottles (250 ml) covered with aluminum foil were used to collect samples from Khodan tannery Khartoum –north Sudan. Samples were stored at 4 °C until physicochemical and microbial analysis.

### 2.2. Determination of Heavy Metals concentration:

Tannery wastewater samples were filtered using filtered paper (Wattman 9 cm pore size 0.45 µm) then diluted with sterile water. The initial and final concentrations of Ni, Cd, Cr, Zn and Pb analyzed by atomic absorption spectrophotometer (BUCK, model 210 VGP). The removal efficiency of the microorganisms was calculated from the difference between initial and final concentrations.

### 2.3. Isolation and identification of Bacteria from Tannery Effluent wastewater:

Serial dilutions of the wastewater samples were prepared. Plated on the nutrient agar (NA) and MacConkey Agar medium with the prepared dilutions ($10^{-4}$) followed by incubation at 37°C for 24 hours. Strains were maintained in agar slants containing nutrient agar. The isolated bacteria were transferred from time to time to new medium in order to sustain their metabolic activity.

After Gram staining, metal resistant bacteria was Isolates and sub cultured on Citramide agar media and biochemically analyzed for their activities of oxidase, catalase, MR- VP test, starch gelatin hydrolysis, motility, indole production and citrate utilization. The tests were used to identify the isolates according to Bergey's Manual of Determinative bacteriology[20, 21].

### 2.4. Preparation of metal solution:

Different concentration (50, 100, 300, 500, and 1000ppm) of heavy metals in the chemical formulas of Ni $(NO_3)_2$ $6H_2O$, Cd $(NO_3)_2$. $2H_2O$, $K_2Cr_2O_7$, Pb $(C_2H_3O_2)_2$.3(H2O), and $H_2O_5SZn$ were added to a distilled water (250 ml) as shown in table 1.

**Table (1):** Preparation of Different of Concentrations of Heavy metals in (250 ml) Distilled Water.

| Doses (ppm) | 1000 | 500 | 300 | 100 | 50 |
|---|---|---|---|---|---|
| **Ni (NO3)2 · 6 H2O** | 0.778 | 0.389 | 0.233 | 0.0778 | 0.0389 |
| **Cd $(NO_3)_2$. $2H_2O$** | 0.525 | 0.2625 | 0.157 | 0.0525 | 0.0262 |
| **K2Cr2O7** | 1.414 | 0.707 | 0.424 | 0.1414 | 0.0707 |
| **$Pb(C_2H_3O_2)_2 \cdot _3(H_2O)$** | 0.457 | 0.229 | 0.137 | 0.0457 | 0.0229 |
| **H2O5SZn** | 0.685 | 0.342 | 0.205 | 0.0685 | 0.0342 |

### *2.4. Preparation of stock bacteria:*

A loop full of each isolated bacteria was inoculated into a 100ml of nutrient broth medium and incubated at 37°C in shaking incubator at 80 revolution per minute for 24 hours then stored at 4 °C or further use.

### *2.5. Sustainability of metal resistant bacteria on agar media:*

*Pseudomonas aeruginosa* on nutrient agar medium supplemented with 50, 100, 300, 500, and 1000 ppm of Cd, Cr, Pb, Zn and Ni. The metals were added to nutrient agar medium sterilized at 121°C (15 psi) for 15 min and allowed to cool to 40-45 °C, then transferred into Petri plates. Then 0.1 ml of the nutrient broth containing *Pseudomonas aeruginosa* supplement was spread on the surface of the agar plates then incubated at 37ºC for 2 days. The metal tolerant bacterial strains were detached by selection pressure method at maximum concentration (1000 ppm). The numbers of *Pseudomonas aeruginosa* colonies that able to grow were counted.

### *2.6. Reduction of heavy metals using Pseudomonas aeruginosa:*

Five hundred ml Flasks containing 250 ml nutrient broth supplemented with different concentrations of chrome, lead, zinc, nickel and Cadmium as mentioned in table (1) were used. Flasks were inoculated with 15 ml of overnight culture of *Pseudomonas aeruginosa* on shaker (80 rpm) at 37°C. After 6, 12 and 24hours concentrations of elements measured by the atomic absorption technique.

The percentage of removal heavy metals (Zn, Cd, Cr, Zn and Pb) was calculated as Equation 1:

$$\%Removal = \frac{\text{initial concentration} - \text{final concentration}}{\text{Initial concentration}} \times 100$$

## 3. Results

Nine bacterial strains were picked up from Tannery effluent wastewater samples. One of the potential strains showing a high degree of metal resistance was selected for further studies. *Pseudomonas aeruginosa* strain isolated by the selection pressure method was identified by performing morphological, cultural and biochemical tests and the results were compared with Bergey's Manual of systematic Bacteriology (Table 2).

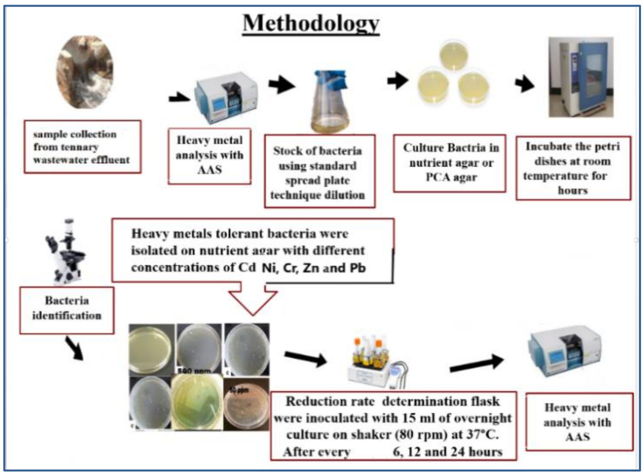


**Fig. 1:** Laboratory process of heavy metal biosorption by *Pseudomonas aeruginosa.*

The effluent sample analyzed had a pH value of (5.7). The total suspended solids (1320.5 mg/L). COD and BOD were found to be 5292.6 mg/L and 2989.9 mg/L respectively. In the effluent sample analyzed chromium was found to be 0.4070 mg/l in the effluent. Other metals like cadmium, lead, nickel and zinc were present at levels of 0.0030, 0.0211, 0.0140 and 0.0240 mg/L respectively.

**Table (2):** Characteristics of bacterial isolate from tannery effluents

| Tests | Isolated bacteria |
|---|---|
| **Morphology** | Rod |
| **Pigments** | Green |
| **Gram stain** | Negative |
| **Motility** | Positive |
| **Catalase** | Positive |
| **Oxidase** | Positive |
| **Endospore staining** | Negative |
| **.O/F** | O |
| **Glucose** | Positive |
| **Growth in Air** | Positive |
| **Growth on Citramide** | Positive |
| **Growth on MacConky** | Positive |
| **Results** | ***Pseudomonas aeruginosa*** |

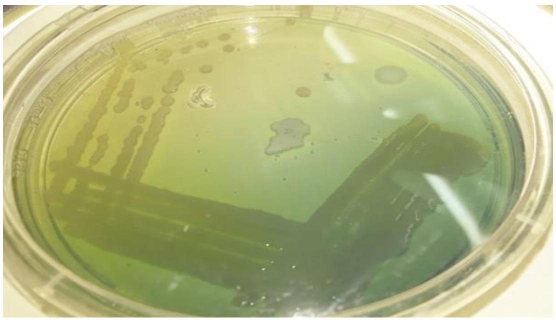

**Fig. 2:** *Pseudomonas aeruginosa* cultured on nutrient agar.

### 3.1. Isolation of heavy metal-resistant strain:

*Pseudomonas aeruginosa* was isolated from tannery effluent waste water by serial dilution and pour plating methods. selection pressure method was used to determine the ability of *Pseudomonas spp* to survived in nutrient agar supplemented with different heavy metals with concentrations of 50,100, 300, 500 and 1000 ppm. As shown in table (3), growth was highest at 50 ppm after 2 days for nickel and lead incubation.

The *P. aeruginosa* strain had a high growth rate generally resistant to heavy metals, while growth and resistance decreased with increasing concentrations of heavy metals. Cd showed the low-peak values when compared to other metals whereas in the minimal medium Ni and Pb showed highest peak values. At lower concentrations, numerous well developed colonies were visualized. But, at 500 and 1000 ppm of concentration, No colonies were formed.

**Table (3):** Counting of *Pseudomonas aeruginosa* growth (CFU\ml) in different concentrations of heavy metals (ppm) after 48 hours at 37° C:

| Heavy metals | 1000 | 500 | 300 | 100 | 50 |
|---|---|---|---|---|---|
| Ni | No growth | No growth | $2.0\times10^4$ | $1.8\times10^5$ | $5.0\times10^6$ |
| Cd | No growth | No growth | $3.0\times10^4$ | $4.0\times10^4$ | $3.0\times10^5$ |
| Cr | No growth | No growth | $1.5\times10^4$ | $5.0\times10^4$ | $1.6\times10^6$ |
| Pb | No growth | No growth | $8.0\times10^4$ | $6.0\times10^5$ | $9.0\times10^6$ |
| Zn | No growth | No growth | $4.0\times10^5$ | $4.0\times10^4$ | $4.3\times10^5$ |

As shown in **table 3,** *Pseudomonas aeruginosa* showed great resistance against 300 ppm of selected heavy metals. Among the heavy metals Ni and Pb were less toxic, whereas Cr medium toxic but Cd and Zn were highly toxic to *Pseudomonas aeruginosa* strain. However, the growth performance of *Pseudomonas aeruginosa* resistance is very high against different concentrations of chromium, zinc, lead, cadmium, and nickel.

### 3.2. Biosorption of metals tolerant bacteria:

Metal uptake capacity was investigated using heavy metals at different time intervals of growth from 6 and 12 up to 24 h. Decrease of metal concentration in solutions was observed with the increase in growth due to efficient uptake of metals with a maximum time at 24 h. As shown in Figure (1), reduction rate of Cd increased as the incubation time was increased for each concentration level of Cd. It was found in the ranged 60.1 to 83.4%. Moreover, it has been observed that the higher reduction rate in Cd concentration occurred after 6 hours incubation time for all Cd concentration levels, which was found to be 76.4, 82.1 and 83.8% for the concentrations 50, 100 and 300 ppm respectively as show in Figure 1. Further incubation time had no affected just a small decrease after 12 hours which was observed in the cadmium removal by *Pseudomonas.*

As we can see in Figure (5), reduction rate of Pb was increased when the incubation time was increased for 100 ppm and 300 ppm concentration level of Pb. It was found in the ranged 95.8 to 97.5% respectively at 24 hours incubation. Moreover, it has been observed that the higher reduction rate in Pb concentration occurred after 24 hours incubation time. The lowest reduction rate was recorded at 50 ppm Pb concentration it was found in the ranged of 87.3%, 90.4% and 79 % at 6 h ,12 h and 24 hours respectively. In Figure (3) showed that *Pseudomonas* is very effective in removal of chromium the rate of Cr reduction was significantly increased at all the incubation time 6, 12 and 24 hours for each concentration level of Cr, where the reduction rate was between 97.9 to 99.4%.

The reduction rate of Ni after incubation times (6, 12 and 24h) was very high rate; it was ranged between 88.9 to 96.9%.

The ability of *Pseudomonas* to reduce zinc was found in high rates up to 94.4% which observed at 12 hours at 50 ppm and decreased when concentration of Zn increased, as we can see in Figure (4).

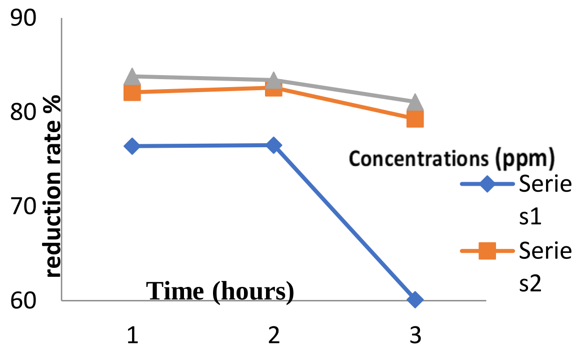


**Fig. 3:** Reduction rate (%) of Cd in aqueous medium Solution with different concentration of cadmium by using *Pseudomonas aeruginosa.*

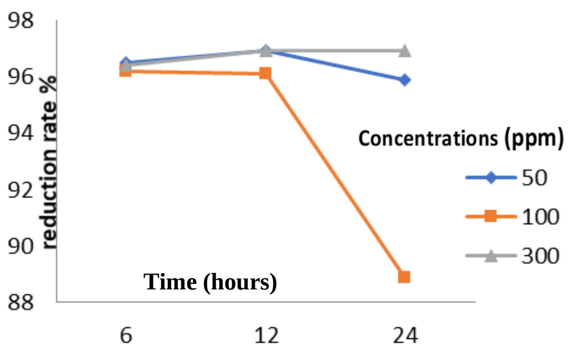


**Fig. 4:** Reduction rate (%) of Ni in aqueous medium Solution with different concentration of Nickel by using *Pseudomonas aeruginosa.*

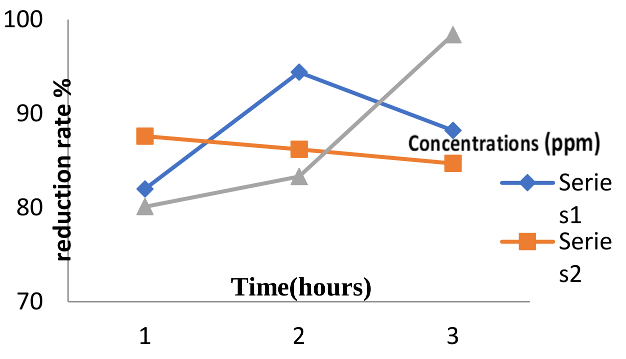


**Fig. 5:** Reduction rate (%) of Cr in aqueous medium Solution with different concentration of chrome by using *Pseudomonas aeruginosa.*

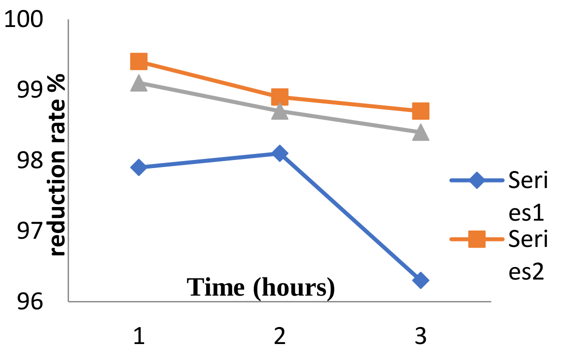


**Fig. 6:** Reduction rate (%) of Zn in aqueous medium Solution with different concentration of Zink by using *Pseudomonas aeruginosa.*

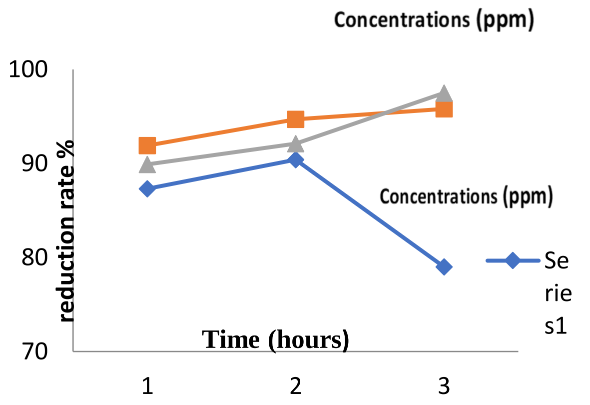


**Fig. 7:** Reduction rate (%) of Pb in aqueous medium Solution with different concentration of lead by using *Pseudomonas aeruginosa.*

## 4. Discussion

The wastewater is a suitable habitat for microorganism; this indicates that only these organisms are able to use the effluent for their growth and metabolism. The presence of bacteria in tannery effluent may be as a result of their capacity to use the compounds within the effluent. According to [22], microorganisms play a vital role in removal of heavy metals from contaminated wastewater, but when microorganisms are exposed to higher concentration of heavy metals, it may have deleterious effects on their growth and activities.

In this study, the susceptibility and resistance of *Pseudomonas aeruginosa* isolated from tannery effluent waste water towards some heavy metals was investigated, it was evident that *Pseudomonas aeruginosa* showing high tolerance to five heavy metals (Pb, Cr, Zn, Ni and Cd). The limit of tolerance to the highest concentration of selected heavy metals was evaluated according to the ability of *P. aeruginosa* cells to grow on higher concentration.

*Pseudomonas aeruginosa* have been isolated from tannery effluents by several researchers [23],[25]. [26] Reported that *Pseudomonas aeruginosa* was isolated as heavy metals tolerant bacteria. Various living organisms have the capability to remediate pollutants; fungi, bacteria, algae and their oxidative biocatalysts are instrumental in recycling recalcitrant biomolecules and xenobiotic [27], [28]. Bacteria possess a high capacity to degrade a variety of toxicants, chiefly because of the presence of catabolic genes and can withstand extreme environmental conditions [29]. These mechanisms include the formation and sequestration of heavy metals in complexes, reduction of a metal to a less toxic species, and direct efflux of a metal out of the cell. As [30] mentioned, the ability of *Pseudomonas aeruginosa* to grow and survive in the high concentrations of studied heavy metal might be due to three different mechanisms for resistance of heavy metals: Firstly, accumulation of specific ion can be diminishing not by interference with uptake but by using of the heavy metal ion active extrusion from cells and this mechanism is only specific for *Pseudomonas aeruginosa*. Secondly, cations especially the “Sulfur lovers” can be segregated in to complex compounds by thiol containing molecules and then ejected from the cell. Thirdly, some metal ions could also be reduced to a less deadly aerophilic state by the complicated enzymes and special oxidization mechanisms within the cells. They add that for many metals, resistance and homoeostasis is a combination of two or three of the mentioned basic mechanisms that is the case which *Pseudomonas aeruginosa* success.

As results showed, high resistance of *P. aeruginosa* towards heavy metals in surface sediments might be due to the high level of plasmid that makes the bacteria highly tolerant to heavy metal concentrations, especially *Pseudomonas spp*. which can be resistant up to 300 ppm concentration of heavy metal.

As a rule, it is well documented that environmental factors like temperature, pH, low molecular weight organic acids, and humic acids can alter the transformation, transportation, balance state of heavy metals, and the bioavailability of heavy metals towards microorganism’s effect on ability of microbial strain to grow in the presence of heavy metals [31]. Microbial growth would be helpful in the waste water treatment where microorganisms are directly involved in the decomposition of organic matter in biological processes for waste water treatment [32]. In current study as shown in figure 4, the reduction rate of Ni in aqueous solutions contained different initial concentrations of Ni (50, 100 and 300 ppm) after incubation times (6, 12 and 24h) was very high rate, it was ranged between 88.9 to 96.9%. It is well known that several Physico-chemical methods have been employed over the years for the removal of Ni from aqueous solutions [33]. Bioremediation by Gram-negative bacteria, *Pseudomonas spp* has been the better method for the removal of Ni ions from Ni-contaminated media with high reduction rates in different concentration of nickel at 37ºC for 2 days incubation period. On the other hand, [34] isolated *Pseudomonas aeruginosa* from the wastewater of electroplating industry, and found it able to absorb chromium, nickel and zinc, by 20% concentration. The highest percentage of the reduction was observed in nickel after 10 days and lowest for 10 days chromium, they concluded that the bacteria can be used as bio sorbents.

Furthermore, the ability of *Pseudomonas* to reduce zinc, was found in high rates up to 94.4% which observed at 12 hours at 50 ppm as tabulated in figure 6, It has been reported that The removal of zinc from polluted environments by using *pseudomonas* spp. has been highlighted in several bioremediation studies [35] showed that *pseudomonas aeruginosa* was an efficient bio sorbent in the removal of Zn (II) ions from an aqueous solution in similar bio sorption conditions.

On the other hand, reduction rate of Cd increased as the incubation time was increased for each concentration level of Cd. It was found in the ranged 60.1 to 83.4%. Moreover, it has been observed that the higher reduction rate in Cd concentration occurred after 6 hours incubation time for all Cd concentration levels, which was found to be 76.4, 82.1 and 83.8% for the concentrations 50, 100 and 300 ppm respectively, as show in figure 3. Further incubation time had no affected just a small decrease after 12 hours which was observed in the cadmium removal by *Pseudomonas.*

[36] reported that *P. aeruginosa* can remove more than 75% Cd within 60 min from the medium during the active growth periods and observed that under nutrient sufficient condition the bacterial strain removed almost 89% of the Cd from the wastewater after 96 hours. They also reported that the strains from the genus *Pseudomonas* have the potential to remove Cd because of its good bio sorption efficacy [37].

Additionally, several studies reported that *Pseudomonas aeruginosa* has efficiency for metal uptake and bio sorption of cadmium (II) and lead (II) ions from solution

[38] this findings agree with result in current study in which the reduction rate of Pb was increased when the incubation time was increased for 100 ppm and 300 ppm concentrations level of Pb. It was found in the ranged 95.8 to 97.5% respectively at 24 hours incubation as figure 7 shown. Moreover, it has been observed that the higher reduction rate in Pb concentration occurred after 24 hours incubation time. The lowest reduction rate was recorded at 50 ppm Pb concentration it was found in the ranged of 87.3%, 90.4% and 79 % at 6 h, 12 h and 24 hours respectively as shown in figure (5) in a similar study,[39] found that removal of the metals was carried out on the cell surface by adsorption and cell uptake. *P. aeruginosa* strain removed 84 % of 204.3 ppm at 37 ° C incubation time for 24 hours.

The present work indicates that *Pseudomonas* is very effective in removal of chromium the rate of Cr reduction was significantly increased at all the incubation time 6, 12 and 24 hours for each concentration level of Cr, where the reduction rate was between 97.9 to 99.4%. This result agree with [40] who approved that There was a considerable and gradual reduction in the absorbance values and Cr concentration every hour. The concentration of total Chromium in the effluent was reduced to 30 mg/l from 630 mg/l after 192 h of treatment which showed efficiency in remediation of chromium by *P. aeruginosa* removed Cr with 91.2%. Furthermore, incubation time and Cr concentrations level up to 300 ppm had no effect on the ability of *Pseudomonas* to remove Cr as shown in figure 5. The bioremediation of chrome by *Pseudomonas* was investigated under laboratory as well as field conditions. At the optimal conditions, metal ion uptake increased with initial metal ion concentration up to 100 ppm. Numerous natural bio sorbents of microbial origins have been related to efficient bio sorption characteristics. These bioremediations have assisted with improving their metal-binding properties. Increasment the general expense of the process. Regardless of such deficiencies, both native and modified bio sorbents have demonstrated their compatibility when tested with tannery effluent. These bio sorbents showed effective metal removal over a wide range of temperature, pH, and solution conditions [31].

## Conclusion

The results indicate that *Pseudomonas aeruginosa* exhibited significant efficacy in removing these metals from solution, achieving average reductions of 76.4%, 96.9%, 94.4%, 97.3%, and 95.8%, respectively, within the initial 6 hours of incubation. The demonstrated capability of *Pseudomonas aeruginosa* underscores its potential as a highly effective and environmentally friendly agent for bioremediation purposes. Given these findings, more research is recommended to study the ability of this species to remove Cd, Ni, Cr, Zn and Pb in different conditions.

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مقالة بحثية

# الإمكانيات البيئية لـ *Pseudomonas aeruginosa* في تخفيض تلوث المعادن الثقيلة في مياه الصرف الصناعي

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استلم في: 15 نوفمبر 2023 / قبل في: 02 ديسمبر 2023 / نشر في 31 ديسمبر 2023

## المُلخّص

أدت التطورات الصناعية إلى تلوث البيئة بالمعادن الثقيلة السامة التي انتشرت في جميع أنحاء العالم. يتميز تلوث المعادن الثقيلة بسميته المتزايدة ومقاومته للتحلل البيولوجي وتراكمه البيولوجي، بتهديد كبير لكل من صحة الإنسان واستقرار البيئة. تقدم الأنشطة الميكروبية سبيلاً محتملاً لتثبيت وإزالة وتنقية أيونات المعادن الثقيلة النشطة في البيئة الطبيعية. هدفت هذه الدراسة إلى دراسة قدرة Pseudomonas aeruginosa على تقليل كميات الكادميوم ، الزنك، النيكل، الكروم، الرصاص التي توجد في مياه صرف مصانع الدباغة وفحص قدرتها على البقاء على قيد الحياة في تراكيز عالية من هذه المعادن .في هذه الدراسة، تم فصل Pseudomonas aeruginosa من مياه صرف مصانع الدباغة. تمت زراعة Pseudomonas aeruginosa في وسط يحتوي على 50 و 100 و 300 و 500 و 1000 جزء في المليون من Cd و Ni و Cr و Znو Pb لمدة 6 و 12 و 24 ساعة عند درجة حرارة 37 °C. أظهرت النتائج أن Pseudomonas aeruginosa كانت قادرة على التسبب في تقليل كبير لكميات Cd و Ni و Cr و Zn و Pb بعد 24 ساعة من الحضانة عند تركيز 50 و 100 و 300 جزء في المليون. كانت نسب التقليل كالتالي Ni :(96.5%، 96.2%، و 96.4%) على التوالي، Cd(76.4%، 82.1%، و 83.8%) على التوالي، Cr(97.7%، 99.4%، و 99.1%) على التوالي، Pb(87.3%، 91.9%، و 89.6%) على التوالي، و (82%، 87.6%، و 80.1%) على التوالي لـ Zn. لم تكن Pseudomonas aeruginosa قادرة على النمو عند مستوى تركيز 500 و 1000 جزء في المليون لـ Cd و Ni و Cr و Zn و Pb. تشير هذه النتائج إلى أن Pseudomonas aeruginosa قادرة على البقاء على قيد الحياة في مياه صرف مصانع الدباغة التي تحتوي على مستويات عالية من Cd و Ni و Zn و Cr و Pb. لذلك، يُفضل إجراء مزيد من البحوث لدراسة قدرة هذا النوع على إزالة Cd و Ni و Cr و Zn و Pb في ظروف مختلفة.

**الكلمات المفتاحية:** *Pseudomonas aeruginosa*، تنقية المعادن الثقيلة، بكتيريا مقاومة للمعادن الثقيلة، امتصاص.

## How to cite this article:

N. A. M. Ibrahim, S. O. Yagoub, “REDUCTION RATE OF SOME HEAVY METAL IN DIFFERENT CONCENTRATIONS USING *Pseudomonas aeruginosa* ISOLATED FROM TENNARY WASTEWATER EFFLEUNT”, *Electron. J. Univ. Aden Basic Appl. Sci.*, vol. 4, no. 4, pp. 361-369, December. 2023. DOI: https://doi.org/10.47372/ejua-ba.2023.4.304