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ISOLATION OF HEAVY METAL TOLERANT YEASTS FOR BIOSORPTION LEAD AND CADMIUM

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ABSTRACT

This work aims to isolate heavy metal tolerant yeasts and to study their ability to biosorpe lead and cadmium cations at different concentrations. Effects of microbial biomass and its exposure time on metal biosorption were studied as well. Only two isolates showed high tolerance to Pb and Cd. They were identified by Biolog Microbiology 3.70 software as yeast isolates of *Candida incommunis* and *Wickerhamiella domercqiae*. The results revealed that the specific metal uptake values increased with increasing initial metal concentration and exposure time while specific metal uptake exhibited lower values when the dried cells of both yeast isolates increased from 1 to 2 g/l. *W. domercqiae* was more efficient in Pb and Cd biosorption than *C. incommuins* at any weight. The Pb treatments supplemented with 1 or 2 g/l of *C. incommunis* dried cells showed low ability for Pb sorption. The maximal specific Pb uptakes after 360 min exposure time were 22.55, 36.38 and 37.11 mg/g or 15.55, 24.15 and 25.38 mg/g when the Pb treatments supplemented with 40, 80 and 120 mg/l, respectively. The Cd treatments supplemented with 1 or 2 g/l of *C. incommunis* dried cells showed low ability for Cd sorption. The maximal specific Cd uptakes after 360 min exposure time were 7.19, 11.32 and 13.451 mg/g or 4.14, 6.25 and 7.43 mg/g when the Cd treatments supplemented with 10, 20 and 30 mg/l, respectively.

INTRODUCTION

Mobilization of heavy metals in the environment due to industrial activities is of serious concern because of their toxicity towards humans and other forms of life. Removal of toxic heavy metals from industrial wastewaters is essential from the standpoint of environmental pollution control (Martins *et al.*, 2006). Lead is widely used in many industrial applications such as storage battery manufacturing, printing, pigments, fuels, photographic materials and explosive manufacturing (Jalali *et al.*, 2002). Lead is high toxic, causes adverse health effects such as anemia, encephalopathy, hepatitis and nephritic syndrome (Lo *et al.*, 1999). Cadmium contributes markedly to the environmental pollution, especially waters and soil. It is usually found in low concentrations but the toxicity of Cd ions is high relative to that of other heavy metals. Chronic exposure to cadmium can lead to the accumulation of cadmium in kidney and caused renal damage.

Conventional processes used for heavy metal removal from industrial wastewaters include chemical precipitation, ox reduction, filtration, electrochemical techniques and sophisticated separation processes using membranes. These processes are usually expensive when heavy metals are present in moderate concentrations, such as 1 to 100 mg/l (Ilhan *et al.*, 2004). This characteristic stimulates the use of alternative biotechnologies, due to their reduced cost and lower aggressiveness to the environment.

In the past few decades, biosorption using microbial biomass, as adsorbent agents, has emerged as a great potential and inexpensive technique for metal removal. The amount of accumulated cations can be large and depends on many factors ranging from the microbial species and its physiological state to external physicochemical conditions such as pH and temperature, etc. (Xu *et al.*, 2004). Other important factors affecting the accumulation capacity are the type of the cation, its valency, the presence of other cations or anions, complexing agents, inhibitors of microbial growth and resistance to stress factors (Olasupo *et al.*, 1993).

The mechanisms of metal binding to microbial biomass can be roughly divided into three main types (Kujan *et al.*, 2005). These three main types are Intracellular accumulation (this process requires live cells), sorption or complex formation on cell surface (it takes place on both live and dead cells) and extracellular accumulation or precipitation (the process may require viable cells). Yeasts are known to be selective metal biosorbents as compared to fungi, actinomycetes and bacteria (Zouboulis *et al.*, 1999). The application of *S. cerevisiae* as a biosorbent not only removes metals from wastewaters but also eases the burden of disposal coasts associated with the waste (Ting and Sun, 2000)

This work aims to isolate heavy metals tolerant yeasts and to study their ability for biosorping lead and cadmium cations at different concentrations. Effect of biosorbent weight and its exposure time on metal biosorption was also studied.

MATERIALS AND METHODS

Sample collection:

Soil samples were taken from Helwan agricultural fields which received industrial effluents from Steel and Iron Factory for isolation of heavy metals tolerant microorganisms. Some soil mechanical and chemical characteristics are presented in Table (1).

Metal solution

A stock solution as recommended by Al-Garni (2005) of Pb (1000 mg/l) was prepared by dissolving 1.598 g of lead nitrate in deionised distilled water, shaking it for 15 min and then leaving it to stand for 24 hr to obtain complete dissolution. Similarly, a stock solution of Cd (1000 mg/l) was prepared by dissolving 2.330 g of Cd sulphate in deionised distilled water and treated as mentioned above. The stock solutions were diluted with deionised water to obtain the desired concentrations of the metal under this study. The metals solutions were adjusted to pH 5 using 0.1 N of NaOH or HCl.

Table (1): Some mechanical and chemical characteristics of the experimental soil

Chemical characteristics		Mechanical characteristics (Particle size distribution)	
Character	**value**	**Character**	**Value %**
pH (1:2.5)	8.66	Coarse sand	00.40
EC, dS/m (1:5)	0.98	Fine sand	61.00
Soluble cations (meq/l)		Silt	23.20
Ca^{2+}	5.70	Clay	15.40
Mg^{2+}	2.82	Textural class	sandy loam
Na^{+}	3.36		
K^{+}	0.33	**Total content of some heavy metals (mg/Kg soil)**	
Soluble anions (meq/l)			
CO_3^{2-}	-	Cd	
HCO_3^{-}	1.00	Co	25.80
Cl^{-}	2.50	Cr	0.00
SO_4^{2-}	8.71	Pb	11.10
		Ni	417.40
		Se	10.60
		As	0.00
			0.00

Isolation of heavy metal tolerant microorganisms

Tolerant microorganisms were isolated using soil extract agar medium as recommended by Holm and Jenseon (1972). The medium was supplemented with 50 mg/l Pb (as Pb $(NO_3)_2$) or 10 mg/l Cd (as $3CdSO_4.8H_2O$). Predominant colonies were selected, purified and retested for their tolerance to Pb and Cd on the same medium containing higher concentration of 100, 200, 300 and 400 mg/l for Pb and 20, 30 and 40 mg/l for Cd. Two yeast isolates showed the highest tolerancy to Pb and Cd were identified by Biolog Microbiology 3.70 base and software (Biolog, Hayward, California, USA), (Muller and Ehlers, 2005).

Preparation of yeast powders

Biomass of either the identified yeast isolate was developed by growing the microorganism on potato dextrose broth medium (Waksman and Lechevalier, 1961) at 37 °C for 24 hr. under shaken conditions (120 rpm/min). Cells were harvested by centrifugation at 8000 rpm/min for 15 min. Harvest biomass was washed ten consecutive times with distilled water and dried in hot air oven at 80 °C for 24 hr. To assess complete death of the dried cells, samples of the dried cells were inoculated into potato dextrose agar medium, absence of any growth indicating positive results. The cells were dried to obtain fine powder (0.2 mm) and stored in a refrigerator at 5 °C.

Metal absorption by *Wickerhamiella domercqiae* or *Candida incommunis* powders

A batch equilibrium method was used to determine absorption of different concentrations of Pb (40, 80, and 120 mg/l) and Cd (10, 20 and 30 mg/l) by the powders at concentrations of 1 and 2 g/l. The experiments were conducted by using 250 ml conical flasks containing 100 ml of the tested metal solution and estimated for dried yeast powder. They were incubated in

rotary shaker at 125 rpm/min and 30 °C for 15, 30, 60, 120, 240 and 360 min to study the effect of biosorbent exposure time on metal biosorption. The dried powdered cells were separated by centrifugation at 8000 rpm/min for 10 min and supernatants were acidified to pH < 2 by 0.05 M nitric acid according to APHA (1992) and analyzed for residual lead and cadmium concentrations on Uni Com atomic spectrometer model Solaar 969AA atomic absorption spectrophotometer. Metal adsorbed by the tested dried cells was calculated using the following equation (Vieira and Volesky, 2003):

$$Q = V (C_i - C_f) / m$$

where Q is metal biosorption (mg/g), C_i is initial metal concentration (mg/l), C_f is final metal concentration (mg/l), m is dried weight of biosorbent (microbial biomass) in the reaction mixture (g), and V is volume of the reaction mixture (L) .

RESULTS AND DISCUSSION

Isolation of tolerant microorganisms

Only two isolates *Candida incommunis* and *Wickerhamiella domercqiae* showed high tolerance to Pb and Cd. were identified by Biolog Microbiology 3.70 software (Muller and Ehlers, 2005) as both yeast isolates belong to order Saccharomycetales but *Candida incommunis* family's Dipodascaceae and *Wickerhamiella domercqiae* family's Trichomonascaceae. Their pictures are illustrated in Plates 1 and 2 with a magnification power of 100x.

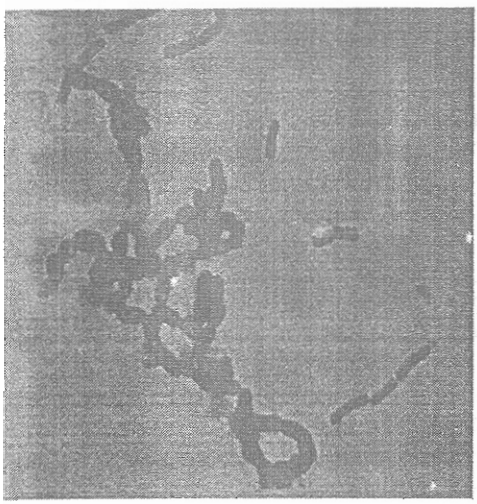


Plate 1. *Candida incommunis*

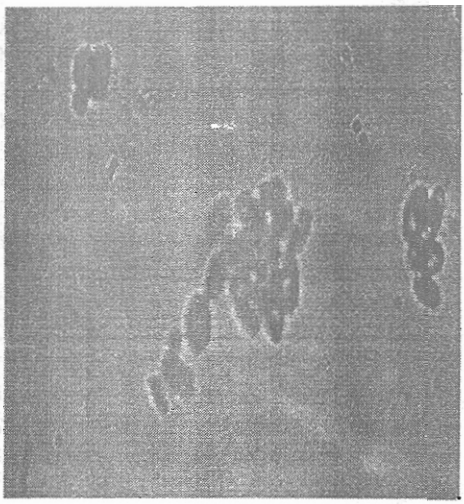
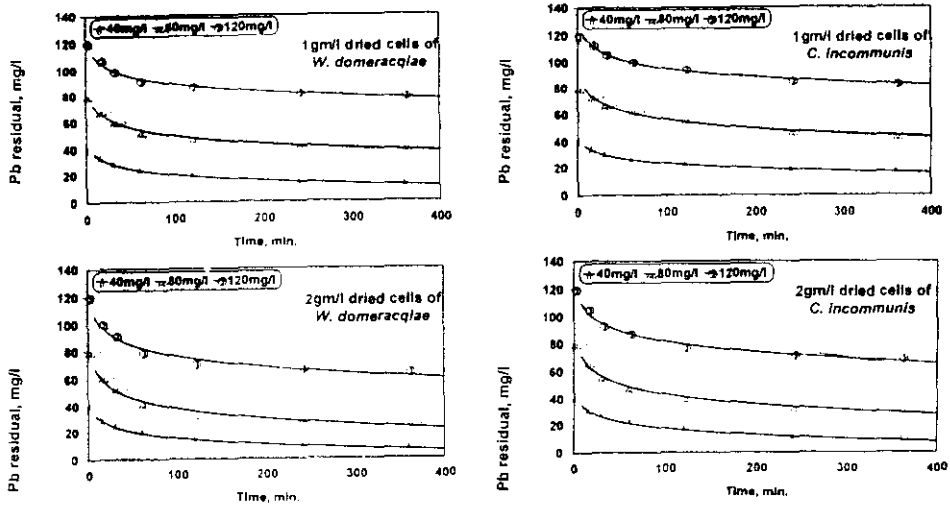


Plate 2. *Wickerhamiella domercqiae*

Lead removal by dried cells of *W. domercqiae* or *C. incommuins*

Changes in lead concentration in distilled water supplemented with different concentrations of Pb (40, 80 and 120 mg/l) under different concentrations of *W. domercqiae* or *C. incommuins* (1 and 2 g/l) against biosorbent exposure time are illustrated in Figure (1).



Figure(1): Residual of lead concentration (mg/l) after treatment by dried cells of *W. domercqiae* or *C. incommunis*.

Concentration of Pb decreased with increasing the exposure time for all Pb concentrations but the decreases were higher when the Pb solution was provided with 2 g/l of either microbial biosorbent. The biosorbent *W. domercqiae* showed ability to adsorb Pb higher than that of *C. incommuins*. During the first 30 min of exposure time, the metal sorption takes place very rapid followed by a slower rate up to a maximum sorption after 360 min. It is known that the rate of metal uptake is influenced by factors affecting mass transfer from bulk solution to binding sites. It was indicated that various steps are involved in the transfer of metal from bulk solution to binding sites. First is the bulk transport of metal ions in solution phase, which is usually rapid because of mixing and advective flow (Gadd, 1988). Second, film transport involves diffusion of metal through a hydrodynamic boundary layer around the biosorbent surface and third, actual adsorption of metal ions by active sites of the biomass is considered to be rapid equivalent to an equilibrium reaction (weber, 1985). Residual Pb concentration curves were found to fit the logarithmic regression model. Equations and correlation coefficients are presented in Table (2). The residual value of Pb for the treatments supplemented with 1 g of dried cells of *W. domercqiae* after exposure time of 360 min decreased from its initial concentration to 11.52, 39.85 and 78.53 mg/l for the 40, 80 and 120 mg Pb/l treatments, respectively. On the other hand, the residual value of Pb after exposure time of 360 min for the treatments supplemented with 1 g of dried cells of *C. incommunis* decreased from its initial concentration to 17.45, 43.71 and 82.89 mg/l for the 40, 80 and

120 Pb mg/l,respectively (Table 3). The removal efficiencies of Pb for the treatments supplemented with 1 g of dried cells of *W. domercqiae* after exposure time of 360 min were 71.20, 50.19 and 34.56 % for the treatments received 40, 80 and 120 Pb mg/l, respectively, while treatments supplemented with 1 g of dried cells of *C. incommunis* showed lower removal efficiencies of pb to 56.38, 45.36 and 30.92 % for the treatments received 40, 80 and 120 Pb mg/l, respectively.

Table (2): Logarithmic Equation And Correlation Coefficients For Pb Residual Concentration In Reactant Solution As Affected By Initial Pb Concentrations, Reaction Exposure Time And Dried Cells Weights

Pb concentration	Yeast dried biomass			
	1 g/l		2 g/l	
	Logarithmic equation	r	Logarithmic equation	r
	W. domercqiae			
40	Pb_w=50.496 -6.598 · ln t	-0.892	Pb_w=47.563 - 6.976 · ln t	-0.856
80	Pb_w=90.611 -8.858 · ln t	-0.834	Pb_w=91.200 -11.550 · ln t	-0.816
120	Pb_w=129.827-6.598 · ln t	-0.831	Pb_w=130.239 -11.747 · ln t	-0.800
	C. *incommunis*			
40	Pb_w=47.956 -5.346 · ln t	-0.852	Pb_w=50.140 -7.033 · ln t	-0.883
80	Pb_w= 99.395 -9.318 · ln t	-0.931	Pb_w=94.487 -11.487 · ln t	-0.841
120	Pb_w=138.906 -9.553 · ln t	-0.910	Pb_w=133.581 -11.273 · ln t	-0.833

Table (3): Removal percentages of Pb by *W. domercqiae* and *C. incommunis* as affected by initial Pb concentrations, reaction exposure time and dried cells weights

Exposure Time, (min)	Biosorbent Conc. of *W. domercqiae*						Biosorbent Conc. of *C .incommuins*					
	1 g/l dried cells			2 g/l dried cells			1 g/l dried cells			2 g/l dried cells		
	Pb concentration (mg/l)						Pb concentration (mg/l)					
	40	80	120	40	80	120	40	80	120	40	80	120
15	18.5	14.81	10.43	29.73	23.35	16.45	14.08	8.30	5.82	24.13	17.14	12.05
30	30.38	24.54	17.46	39.03	33.76	23.63	26.45	16.10	11.85	33.03	26.03	22.39
60	41.83	34.69	23.92	50.63	47.81	34.05	36.70	21.60	16.41	44.93	39.69	27.18
120	50.08	40.71	27.79	66.28	59.29	41.36	45.18	29.61	21.47	58.89	49.75	35.62
240	65.38	47.33	32.11	77.90	66.31	44.78	54.13	40.55	28.83	72.27	58.74	40.16
360	71.20	50.19	34.56	82.70	68.51	46.56	56.38	45.36	30.92	77.75	60.31	42.30

The residual value of Pb for the treatments supplemented with 2 g of dried cells of *W. domercqiae* after exposure time of 360 min decreased from its initial concentration to 6.92, 25.19 and 64.13 mg/l for the 40, 80 and 120 Pb mg/l treatments, respectively. On the other hand, the residual values of Pb treatments supplemented with 2 g of dried cells of *C. incommunis* were 8.9, 31.75 and 69.24 mg/l for the 40, 80 and 120 Pb mg/l, respectively. The removal efficiencies of Pb for treatments supplemented with 2 g of dried cells of *W. domercqiae* after exposure time of 360 min were 82.70, 68.51 and 46.56 % for treatments received 40, 80 and 120 Pb mg/l, respectively, while treatments supplemented with 2 g of dried cells of *C. incommunis* showed lower removal efficiencies of Pb to be 77.75, 60.31 and 42.30 % for the

treatments received 40, 80 and 120 Pb mg/l, respectively. Different Pb removal percentages were reported in the literature using various strains of microorganisms under different environmental conditions. Ceribasi and Yetis (2001) reported removal efficiencies for Pb^{2+} were achieved generally in the first 30 minutes of contact at initial pH 5.0 and initial Pb^{2+} concentration of 50 mg/l. They mentioned that in the first 5 minutes sorption took place very rapidly then it continued slowly and equilibrium was reached in a contact time of 3 hours. The highest sorption capacity of *Phanerochaetec chrysosoporium* for Pb^{2+} was 73.56 mg/g at initial Pb^{2+} concentration of 50 mg/l. Uslu *et al.* (2003) reported that optimum initial pH and temperature for growing cells of *Rhizopus arrhizus* were pH 4.0 and 25 °C, respectively. The culture was able to remove 54.9 and 30.5 % of total Pb^{2+} ions at 50 and 75 ppm initial metal ion. Similarly, Bhattacharyya and Arunima (2004) stated the maximum Pb removal was 85 % by using growing cells of the bacterial strain at 30 °C and pH 6.0 after 30 hours of fermentation when initial lead concentration was 50 mg/l. Runping *et al.* (2006) studied the influence of biomass concentration on lead biosorption by *S. maxima*. They reported that when the biosorbent doses were increased from 0.1 to 2 g/l, the percentages of lead adsorbed increased from 24 % to 84 % in intact biomass.

Cadmium Removal by dried cells of *W. domercqiae* or *C. incommunis*

Changes in cadmium concentration in distilled water supplemented with different concentrations of Cd (10, 20 and 30 mg/l) under different concentrations of *W. domercqiae* or *C. incommuins* (1 and 2 g/l) against biosorbent exposure time are illustrated in Figure (2).

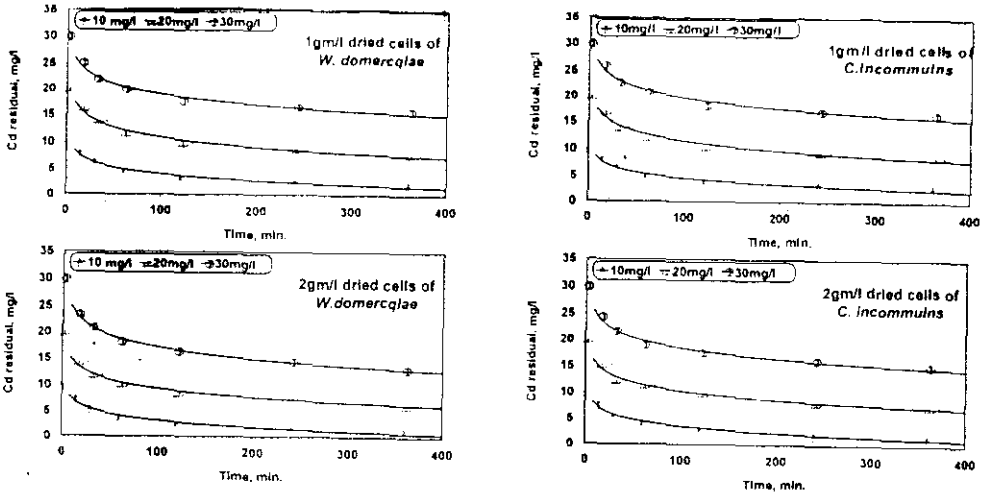


Figure (2): Residual cadmium concentration (mg/l) after treatment with dried cells of *W. domercqiae* or C. *incommuins*.

The highest removal of cadmium by yeast isolates was regularly increased with increasing exposure time and decreasing with increasing initial cadmium concentration. Cadmium biosorption by *W. domercqiae* is more efficient than that by *C. incommuins*. During the first hour of exposure time, a higher capacity of absorbing cadmium is observed and then it continues at a relatively slower rate up to the end of the experimental period. Residual Cd concentration curves were found to fit the logarithmic regression model. Equations and correlation coefficients are presented in Table (4).

Table (4): Logarithmic equation and correlation coefficients for Cd residual concentrations in reactant solution as affected by initial Cd concentrations, reaction exposure time and dried cells weights

Cd concentration	Yeast dried biomass			
	1 g/l		2 g/l	
	Logarithmic equation	r	Logarithmic equation	R
W. domercqiae				
10	Cd_w=12.306-1.819· ln t	-0.815	Cd_w=11.695-1.867 · ln t	-0.797
20	Cd_w=22.676-2.570 · ln t	-0.823	Cd_w=20.027-2.322 · ln t	-0.783
30	Cd_w=33.875-3.018 · ln t	-0.799	Cd_w=31.732-3.183 · ln t	-0.813
C. *incommunis*				
10	Cd_w=11.992-1.630 · ln t	-0.809	Cd_w=12.088-1.859 · ln t	-0.803
20	Cd_w=22.787-2.467 · ln t	-0.814	Cd_w=20.888-2.299 · ln t	-0.803
30	Cd_w=33.354-2.988 · ln t	-0.823	Cd_w=31.532-2.844 · ln t	-0.795

The residual value of Cd for the treatments supplemented with 1 g of dried cells of *W. domercqiae* after exposure time of 360 min decreased from its initial concentration to 2.10, 7.92 and 15.79 mg/l for the 10, 20 and 30 Cd mg/l treatments, respectively. On the other hand, the residual value of Cd after exposure time of 360 min for the treatments supplemented with 1 g of dried cells of *C. incommunis* decreased from its initial concentration to 2.81, 8.68 and 16.55 mg/l for the 10, 20 and 30 Cd mg/l, respectively, (Table 5). The removal efficiencies of Cd for the treatments supplemented with 1 g of dried cells of *W. domercqiae* after exposure time of 360 min were 79.00, 60.4 and 47.37 % for the treatments received 10, 20 and 30 Cd mg/l, respectively, while the treatments supplemented with 1 g of dried cells of *C. incommunis* showed relatively lower removal efficiencies of Cd to be 71.90, 56.68 and 44.83 % for the treatments received 10, 20 and 30 Cd mg/l, respectively. The residual values of Cd for the treatments supplemented with 2 g of dried cells of *W. domercqiae* after exposure time of 360 min decreased from its initial concentration to be 1.12, 6.15 and 13.12 mg/l for the 10, 20 and 30 Cd mg/l treatments, respectively. On the other hand, the residual values of Cd treatments supplemented with 2 g of dried cells of *C. incommunis* were 1.72, 7.50 and 15.15 mg/l for the 10, 20 and 30 Cd mg/l, respectively (Table 5). The removal efficiencies of Cd for the treatments supplemented with 2 g of dried cells of *W. domercqiae* after exposure time of 360 min were 88.80, 69.25 and 56.27 % for the 10, 20 and 30 Cd mg/l treatments, respectively, while the treatments supplemented with 2 g of dried cells of *C. incommunis*

showed lower removal efficiencies of Cd to be 82.80, 62.8 and 49.50 % for the 10, 20 and 30 Cd mg/l treatments, respectively. Ziagova *et al.* (2007) studied the absorption of Cd in binary mixtures with Cr^{6+} ions and reported that Cd biosorption was reaching 96 % and 89 % for *Pseudomans sp.* and *Staphylococcus xylosus*, respectively at 10 mg / Cd^{2+} and 5 mg / Cr^{6+}

Table (5): Removal percentages of Cd by *W. domercqiae* or *C. incommunis* as affected initial Cd concentrations, reaction exposure time and dried cells weights

Exposure Time (min)	Biosorbent Conc. of *W. domercqiae*						Biosorbent Conc. of *C. incommuins*					
	1 g/l dried cells			2 g/l dried cells			1 g/l dried cells			2 g/l dried cells		
	Cd concentration (mg/l)						Cd concentration (mg/l)					
	10	20	30	10	20	30	10	20	30	10	20	30
15	21.80	19.00	16.17	28.10	29.10	21.90	19.70	15.20	12.83	22.90	23.80	18.33
30	38.90	30.70	27.00	47.10	41.20	30.30	36.48	30.45	24.37	44.90	38.35	27.63
60	55.85	41.75	33.60	66.50	49.10	39.50	51.72	39.50	30.57	60.90	42.75	36.50
120	69.50	50.60	41.17	76.50	57.50	45.33	63.29	47.75	39.73	71.90	50.40	41.40
240	76.00	56.00	44.60	83.50	60.40	51.67	68.90	51.95	43.00	81.20	58.55	45.83
360	79.00	60.40	47.37	88.80	69.25	56.27	71.90	56.60	44.83	82.80	62.50	49.50

Specific lead and cadmium uptake as affected by dried cells of *W. domercqiae* or *C. incommunis*

The results shown in Table 6 and 7 reveal that the specific metal uptake values increased with increasing initial metal concentration and exposure time while specific metal uptake exhibit lower values when dried cells increased from 1 to 2 g/l. Data also showed that *W. domercqiae* was more efficient in Pb and Cd biosorption than *C. incommuins*, at any yeast biosorbent weights. For example, the Pb treatments supplemented with 1 g/l of dried cells of *W. domercqiae* showed an increase in the specific Pb uptake values from 7.4, 11.85 and 12.52 mg/g after exposure time of 15 min to 28.48, 40.15 and 41.47 mg/g after 360 min of the experimental exposure time for the Pb treatments received 40, 80 and 120 mg/l, respectively. The Pb treatments supplemented with 2 g/l of dried cells of *W. domercqiae* showed lower specific Pb uptake values than those previously mentioned for Cd, where the specific Pb uptake values after 15 min exposure time increased from 5.94, 9.34 and 9.87 mg/g to 16.54, 27.71 and 27.94 mg/g after 360 min exposure time for the Pb treatments received 40, 80 and 120 mg/l, respectively. The Pb treatments supplemented with 1 or 2 g/l of dried cells of *C. incommunis* showed low ability for Pb sorption. The maximal specific Pb uptakes after 360 min exposure time were 22.55, 36.29 and 37.11 mg/g , for the 1 g/l dried cells, while they are 15.55, 24.13 and 25.38 mg/g, for the 2 g/l dried cells, when the Pb treatments supplemented with 40, 80 and 120 mg/l, respectively.

Table (6): Specific uptake of Pb (mg/g) as affected by initial Pb concentration, exposure time and weights of dried cells of *W. domercqiae* or *C. incommunis*

Exposure Time (min)	Biosorbent Conc. of *W. domercqiae*						Biosorbent Conc. of *C. incommuins*					
	1 g/l dried cells			2 g/l dried cells			1 g/l dried cells			2 g/l dried cells		
	Pb concentration (mg/l)						Pb concentration (mg/l)					
	40	80	120	40	80	120	40	80	120	40	80	120
15	7.4	11.85	12.52	5.95	9.34	9.87	5.63	6.64	6.98	4.83	6.86	7.23
30	12.15	19.63	20.95	7.81	13.51	14.18	10.58	12.88	14.22	6.61	11.91	13.44
60	16.73	27.75	28.70	10.13	19.13	20.43	14.68	17.28	19.69	8.99	15.88	16.31
120	20.03	32.57	33.35	13.26	23.72	24.82	18.07	23.69	25.76	11.77	19.90	21.37
240	26.15	37.86	38.53	15.58	25.53	26.87	21.65	32.44	34.59	14.53	23.50	24.10
360	28.48	40.15	41.47	16.54	27.71	27.94	22.55	36.29	37.11	15.55	24.13	25.38

Table (7): Specific uptake of Cd (mg/g) as affected by initial Cd concentration, exposure time and weights of dried cells of *W. domercqiae* or *C. incommunis*

Exposure Time (min)	Biosorbent Conc. of *W. domercqiae*						Biosorbent Conc. of *C. incommuins*					
	1 g/l dried cells			2 g/l dried cells			1 g/l dried cells			2 g/l dried cells		
	Cd concentration (mg/l)						Cd concentration (mg/l)					
	10	20	30	10	20	30	10	20	30	10	20	30
15	2.18	3.8	4.85	1.41	2.91	3.29	1.97	3.04	3.85	1.15	2.38	2.75
30	3.89	6.14	8.10	2.36	4.12	4.55	3.65	6.09	7.31	2.25	3.84	4.15
60	5.59	8.35	10.08	3.33	4.91	5.93	5.17	7.90	9.17	3.05	4.28	5.48
120	6.95	10.12	12.35	3.83	5.75	6.80	6.33	9.55	11.92	3.60	5.04	6.21
240	7.60	11.20	13.38	4.18	6.04	7.75	6.89	10.39	12.90	4.06	5.86	6.88
360	7.90	12.08	14.21	4.44	6.93	8.44	7.19	11.32	13.45	4.14	6.25	7.43

The Cd treatments supplemented with 1 g/l of dried cells of *W. domercqiae* showed an increase in the specific Cd uptake values from 2.18, 3.80 and 4.85 mg/g after exposure time of 15 min to 7.90, 12.08 and 14.21 mg/g after 360 min of the exposuer time for the Cd treatments received 10, 20 and 30 mg/l, respectively. The Cd treatments supplemented with 2 g/l of dried cells of *W. domercqiae* showed lower specific Cd uptake values than those previously mentioned, where the specific Cd uptake values after 15 min exposure time increased from 1.41, 2.91 and 3.29 mg/g to 4.44, 6.93 and 8.44 mg/g after 360 min exposure time for the Cd treatments received 10, 20 and 30 mg/l, respectively. The Cd treatments supplemented with 1 or 2 g/ of dried cells of *C. incommunis* showed low ability for Cd sorption. The maximal specific Cd uptakes after 360 min exposure time were 7.19, 11.32 and 13.45 mg/g, for the 1 g/l dried cells, while they are 4.14, 6.25 and 7.43 mg/g, for the 2 g/l dried cells, when the Cd treatments supplemented with 10, 20 and 30 mg/l, respectively. These results are in harmony with those of Norris and Kelly (1979) reported that, various species of yeasts also have the ability to sequester cadmium from solutions. *Saccharomyces uvarium* and *Candida utilis* accumulated approximately 0.13 Mol of cadmium per gram of cells. Later, Volesky *et al.* (1993) found that the biosorption properties of *S.*

cerevisiae reported 3 mg of cadmium/g dry mass. On the other hand, Dursun *et al.* (2003) observed that *Aspergillus niger* consumed lead by 86 % when initial lead concentration was 50 mg/l and specific lead uptake was 16.8 mg/g of dry cell at pH 4.5. Recently Krishnakumar *et al.* (2007) found that a rise in lead concentration from 25 to 100 mg/l resulted in an increase in its uptake by *S. cerevisiae* from 0.75 to 2.34 mg/g, respectively. They observed that the carboxylic group on the cell wall of S. *cerevisiae* contributes most significantly to metal biosorption. The carboxyl, phosphate, amino groups, and lipids which contribute most to lead biosorption are negatively charged.

CONCLUSION

It can be concluded that *W. domercqiae* and *C. incommunis* can be used in the removal of lead and cadmium, heavy metals ions, from aqueous polluted solutions due to their rapid rate of metal biosorption. These isolates are inexpensive and an easily available source of biosorbent. At the same time, they are characterized by their lower aggressiveness to the environment.

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عزل بعض الخمائر التى تتحمل عنصرى الرصاص والكادميوم ودراسة قدرتهم على إدمصاص هذين العنصرين

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يهدف البحث إلى عزل بعض العزلات التي لها القدرة على ادمصاص عنصرى الرصاص والكادميوم. وتم التوصل الى عزلتين لهم القدرة على الإدمصاص وتحمل هذين العنصرين تحت الدراسة وتم تعرفيهم بواسطة طريقة Biolog Microbiology ٣,٧٠ software على أنهم نوعين من الخمائر وهم *W. domercqiae and C. incommunis* وفى هذا البحث تم دراسة تأثير بعض العوامل على الادمصاص الحيوي للعنصرين (الرصاص والكادميوم) باستخدام تركيزين من مسحوق الخمائر ١و٢جم/ لتر وثلاث تركيزات من العناصر الثقيلة ١٠و٢٠و٣٠ ملجم / لتر بالنسبة لعنصر الكادميوم و٤٠و٨٠و١٢٠ ملجم / لتر بالنسبة لعنصر الرصاص وتم تقدير إدمصاص العنصرين بواسطة الخمائر تحت الدراسة على فترات مختلفة. وأوضحت النتائج انه بزيادة تركيزات مسحوق الخميرة يؤدي إلى زيادة كمية المعدن المأخوذ فى كلا السلالتين وأظهرت سلالة *W. domercqiae* ألا كثر فاعلية في ادمصاص الرصاص والكادميوم عن سلالة *C. incommunis* عند كلا التركيزين من مسحوق الخميرة المستعملة كما وجد أن استخدام مسحوق خميرة *C. incommunis* كان أقل كفاءة في ادمصاص عنصر الرصاص عند كلا من التركيزين المستعملين ودلت النتائج على كمية عنصر الرصاص المأخوذة بواسطة مسحوق خميرة *C. incommunis* كانت ٢٢,٥٥ ، ٣٦,٣٨ ، ٣٧,١١ ملجم/ جم عند استخدام ١ جم/ لتر من مسحوق الخميرة و ١٥,٥٥ ، ٢٤,١٥ ، ٢٥,٣٨ ملجم/ جم عند استخدام ٢جم/لتر من مسحوق الخميرة وذلك عند تركيزات ٤٠ ، ٨٠ ، ١٢٠ ملجم/ لتر من عنصر الرصاص على التوالي بعد ٣٦٠ ق من التجربة .

أما قدرة مسحوق خميرة *C. incommunis* عند كلا التركيزين ١ أو ٢ جم/لتر في إدمصاص عنصر الكادميوم كانت النتائج المتحصل عليها كالأتي ٧,١٩,١١,٣٢,١٣,٤٥ملجم /لتر او ٤,١٤، ٦,٢٥، ٧,٤٣ملجم/لتر عند استخدام الكادميوم بالتركيزات الآتية على التوالي ١٠ ، ٢٠ ، ٣٠ ملجم/ لتر وذلك بعد ٣٠٠ ق من التجربة هذا وبناء على نتائج هذا البحث فإنة يمكن التوصية باستخدام مسحوق الخلايا الميكروبية في الادمصاص الحيوي لبعض العناصر الثقيلة مما ينتج عنة تقليل التلوث البيئى الناجم عن مخلفات المصانع من العناصر الثقيلة بوسيلة قليلة التكاليف.