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Factors Affecting Biosorption Of Heavy Metals By Powder Pomegranate And Corn Peels

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Abstract : In this study a low-cost adsorbent was designed for treatment of water pollution such as Pomegranate and corn peels, and used it as a biological treatment to remove elements 'Cr, Pb , Cd 'from wastewater in the Public company for Electrical Industries in Waziriyah . Best size of 1000 ɱ particles obtained the highest percentage of adsorption which is 99.7% for corn peel higher than Pomegranate and mixture in the Chromium Cr > Cadmium Cd > Lead Pb. The best acidity level was detected for adsorption in pH 4 ratios of 89.9% for Cr using corn peel, about time, which obtained the highest adsorption in two hours rate of 99.3% of Cr in corn peel. The study proved the efficiency of highest percentage of adsorption of Pomegranate and corn peels of both that are considered to be a non-expensive domestic waste on the biological removal of dangerous environmental pollutants.

Keywords: Heavy Metals , Wastewater, Peel Plants

1. INTRODUCTION

Wastewater with heavy metal and radioactive pollution is considered a big problem, therefore more chemical techniques were applied to treat and remove it such as chemical precipitation, reverse osmosis, activated carbon adsorption, ion exchange, but some of these techniques have higher costs and difficulties associated with applications. However, the biological techniques are considered safe, and much cheaper and almost free of any unpredicted influences such as different plant wastes such as agricultural wastes and fruit peels (Khan et al., 2004; Husson, 2011; Boamponsem et al., 2012; Shartooh, 2012; Mohammed Eid , et al .2018). In global, Fruits are considered remarkable much-increasing in production and the output has been growing annually about 3% percent on the world. Products from a different state to another, in 2010, almost 640 million tons of fruits were gathered throughout the world. In China the production about 81,285 Million Tons. India produces about 6,892 million Tons among which banana (32.6%), citrus (12.4%) mango (22.1%), and pawpaw (6.6%) IHD Indian Horticulture Database,(2013). In the absence of efficient methods of chemical-physical or high-cost treatment of industrial waste, it would be necessary to find other methods using plant wastes materials which are available in large quantities from many operations and almost costless, may be

successful alternative sorbent material (Deans and Dixon, 1992), such as tree bark, , fruit peels, growing plants and peanut skin (tobacco and tomato root tissues) have been used to reduce different heavy metals ions from contaminated water . Pomegranate and corn peels may have significant adsorption capacity for removal of heavy metal ions from industrial wastewater. Peels of these plants contain many molecules which can be used as natural additives such as phenolic compounds, pectin, flavanoneand glycosides (Bocco et al., 1998; Ben-Ali et al., 2017). So, this study was designed to understand concept of adsorption, the important goals designed a low cost adsorbent for wastewater treatment to remove Cr, Cd, Pb elements by detecting an adsorption substance, environment-friendly ,easy to prepare from waste plants to treat environmental pollution such as wastewater of residues consisting of Cr, Cd, Pb and assessing the impacts of several environmental factors such as; pH, contact time, initial metal concentration of capacity of these adsorption materials.

2: Materials and Methods:

2.1: Samples Collection and Milling:

Pomegranate and corn were purchased to use peels plant waste was separated simply of each type from local markets in the city of Baghdad the peel was washed with distilled water to remove adhering external dirt and then dried 3 days under the sun. Dried peels were crushed and milling into powder by home mill then dried in a hot air oven at 110C for 3h the moisture content was lost from powder and kept in an air tied bottle for experimental uses, four particle size sieves (500 - 212 - 180) µ were used to get four different particle size and then grinded again in Planetary ball mill for 30 h 1:15 ball ratio to get fine particle size near to Nano size according to Nano approach (Top-down) (filippoui and Sutherland, 2013). Also stored the powder in plastic containers for experiment used. All samples were stored in dry place to use for biosorption tests experiments in three phases; Corn peels powder, Pomegranate peels powder and used the mix of powder of peels them.

2.2: General Description of the Study Area

During March in 2021, we have been sampling from Industrial Wastewater was brought from the Public company for Electrical Industries in Waziriyah area on the city of Baghdad to determine some heavy metal concentration Cd, Cr, Pb using Atomic Absorption Spectrophotometer (AAS). Water samples were collected from the industrial ponds about 5ml water of each pond by using 5 litter containers, The water samples were immediately filtered through 0.45µ Millipore filters, The filtrates were according to standard methods, Heavy metal ions to measure before and after addition of adsorbents powder.

2.3: Factors Affecting Biosorption of Heavy Metals: (Abdulla, 2017).

The main investigated parameters that may influence metal sorption were; pH, temperature, contacting time, Biosorbent weight, heavy metal initial concentration, particle size of waste peels for cited reference (Chen, et .al 2011).

2.3.1 PH Effect:

An experiment was carried out at a range of solution pH between 2, 4 for Cd, Cr and pb, because pH above 6 will precipitates metal ions (Asku et al., 1991; Pavasant et al., 2006). The acidic and alkaline pH of the solution was maintained by adding the required amount of Nitric acid and NaOH solutions (Arivoli et al., 2009).

2.3.2 Contacting Time:

The effect of period of contact time between the adsorbent and adsorbate on the removal of the metal ions was determined by keeping pH, temperature, weight, particle size and initial concentration constant according to Arivoliet al., (2009), by different periods (15min., 30min).

2.3.3 Heavy Metal Initial Concentration:

This experiment was carried out by several metal concentrations which were; 10, 50, 100, 250, 500 mg/l, with the fixation of all other factors (Ahalya et al., 2005).

2.3.4 Particle Size of Fruit Peels:

The biosorption of cadmium, Chromium and lead by Banana and orange peels was investigated at five different particle sizes which were (500-212-180 and 30 h).

3- RESULTS AND DISCUSSION:

Investigation of the important parameters that influence metal sorption, were including: pH , Contacting time, Initial concentration and Particle size of plant powder Peels as following :

Cadmium	**PH1**	**PH2**	**Absorption**	**PH1%**	**PH2 %**
CP	6.4	4.99	CP	93.6	95.01
PP	8.27	6.99	PP	91.73	93.01
MP	10.88	9.67	MP	89.12	90.33
Chromium	**PH2**	**PH4**	**Absorption**	**PH2 %**	**PH4 %**
CP	4.6	3.1	CP	95.4	96.9
PP	6.23	4.78	PP	93.77	95.22
MP	7.1	5.99	MP	92.9	94.01
Lead	**PH2**	**PH4**	**Absorption**	**PH2 %**	**PH4 %**

CP	8.99	6.99	CP	91.01	93.01
PP	9.12	7.89	PP	90.88	92.11
MP	11.9	8.99	MP	88.1	91.01

1-pH

These experiments in current study were carried out at four different means of pH values (1,2) for Cd ,Cr and Pb solutions, for powder Pomegranate and corn peels and a Mixture of both respectively chosen these values of pH which were conducted in the same these values of pH , have achieved high rates of removal of the same elements Cadmium, Lead and Chromium using different adsorbent materials pH results showed that increased with increase conditions for the maximum adsorption there is significant correlation between pH concentration and adsorption ratio due to competition between H ions and metal ions this corresponds to (Jameel et al, 2012; Dubey et al, 2014). Very important factors to affect the biosorption of metal to examine the effect of pH on the efficiency biosorption, several experiments were performed at different ranges from 2, 4, 5, 6 as shown in Table and Fig (1) increasing progressive up 2 pH to pH 6 where the maximum adsorption efficiency was obtained and removal rate reached Cd ,Cr and Pb up to (98% and 99%, 97%) respectively. The highest adsorption rate for cadmium was 98% in pH 6 for corn peel .The highest adsorption of chromium was 99% in pH 6. The highest adsorption of the lead element was 97% in pH 6 .On the Table (1) Shows Concentration and adsorption of each elements in Different pH Value. And this result deals with (ALkusaibi.et.al ,2015) when used different value of pH 2,4,6,8,10 and this study prove the best adsorption ratio in ph value 6 ,8 and this result also agreed with (Darge& Mane, 2015) , that used 3,5,8 of pH value and prove 5,8 pH was best to get of high adsorption ratio an also agreed with (Ben-Ali, 2017) were used the value of pH 1 ,2 ,3 ,4, 5 and the result of high adsorption ratio in 4 and 5pH.

Table (1) pH values with concentrations of heavy elements

C: Corn , P : pomegranate, M:Mixed

2- Contact time (Flow rate time):

Different time which is an important factor has a positive effect on concentrations with heavy element In the current results found the contact between time adsorbent to removal of the metal ions was determined and calculated from the column range between (15 min, 30 min.) significantly enhanced by increasing the contact time up to 120 min efficiency was obtained removal rate reached Cd ,Cr and Pb Respectively up to (99.39% adsorption ratio in 1 min Chromium and 98.5% Cadmium in 30 min and 99.29% in 15 min in Lead) as showed in Tables (2), concentration and adsorption elements in Different time Results agreed with several studies achieved a maximum removal of Pb and or Cd such as

(Keskinkan et al .2004) in which the contact time was 20 minute for removal Pb by C. demersum (Zadeh et al.,2014) at 40 min, (Dixit et al., 2014; Thijar et al; 2014, ;Hassoon, 2015) was contact time in their studies (30 minute) for removal of Pb or Cd by C. demersum. and the result of this study agreed with (ALkusaibi, etal., 2015) which was conducted at different time 30 , 60 ,90 , 120, 150 min The process of adsorption starts from the first minute, which the powder touches with the solution and increases with time as the materials become more susceptible and available for adsorption until the powder saturation of the ions found in the solution . Also deals with (Hossain et. al. ,2012) which used different time 10 ,20 ,30 ,40 ,50 ,60 min Where the study proved that the rate of adsorption decreases over time due to the saturation phase.

Table (2) : Concentration Each Elements in Different Time

Cr	**15min**	**30min**	**Adsorption**	**15min %**	**30min%**
CP	1.1	0.61	CP	**98.9**	99.39
PP	2.1	1.2	PP	97.9	98.8
MP	2.9	2.5	MP	97.1	97.5
Cd	**15min**	**30min**	**Adsorption**	**15min %**	**30min%**
CP	2.1	1.5	CP	97.9	**98.5**
PP	2.2	2.8	PP	97.8	97.2
MP	3.7	3.6	MP	96.3	96.4
Pb	**15min**	**30min**	**Adsorption**	**15min %**	**30min%**
CP	0.71	0.9	CP	**99.29**	99.1
PP	1.3	1.1	PP	98.7	96.9
MP	1.9	2.1	MP	98.1	97.9

3- Particle size of Plant Powder

The biosorption of Cr, Pb , Cd ions by investigating in the current study at different particle sizes. Maximum biosorption for powder of it at 1000 µm and 100 ppm . The biosorption of Cd ions was (98.11.%) more than that of Pb ions was (97.38% by corn , While the biosorption of both metals was decreased when the particle size of powder was decreased to 500 µm and ,212,180 µm . Our results agreed with Hassun, 2011; Bulgariu and Bulgariu, 2013; Rosales et al., 2015). Probably due to an increase in the total surface area, which provided more sorption sites for metal ions Corresponds to

(Ho et al., 2001; Dang et al, 2009) compared the biosorption efficiency of wheat straws (particle size 2 cm) with green seaweed (particle size 1000– 4000 µm). They indicated that the metal ion biosorption was five times lower on wheat straw compared to green seaweed. The reasons behind the lower metal ion biosorption onto wheat straw surface were dedicated to absence of surface functional groups and large particle size of biomass. In particularly, the lower particle size offers a proficient surface area for metal ion binding adsorption on biomass surface. The higher level achieved in some of the studies by smaller particle size of the biosorbents may not be connected to the fact that smaller particle sizes would give large surface areas. Although this was contrary to the expectation for an intra-particle diffusion controlled process recommended by (Demirbasa et al., 2004). It can be seen that the surface area per volume is higher for small particles. Accordingly, surface area would increase binding sites and contact surfaces, which results in higher mass transfer and more rapid sorption than that when larger particles are used (Ho et al., 2001; Demirbas et al., 2004; El-Said, 2010) Table (3) Showed the Concentration, adsorption and Particle size of Plant Powder . In study Hossain , 2012 were used different particle size 600 ,420 ,300 , 150 ,75. this study prove the increase rate of adsorption is being by decrease of particle size from 600 to 75 due to surface area which increased by decrease of particle size (Oyewe et al., 2016) also this study used 65000 ,300 ,65 ,25 of particle size . The results of the current study showed that the rate of adsorption increases by increasing the particle size also agreed with (EZE et al., 2013) used different particle sizes 400-600>600-850> 850-1200 µm, The results indicated that the amount adsorbed by each individual particle size showed that 850-1200 µm .

Table (3) : Concentration and Particle size of Plant Powder

500 M	**Cr**	**Cd**	**Pb**
CP	9.3	8.85	10.6
PP	14.1	15.1	18.7
MP	12.2	13.7	14.7
212 M	**Cr**	**Cd**	**Pb**
CP	2.6	10.6	3.6
PP	5.4	12.1	4.7
MP	6.5	13.7	6.1
180 M	**Cr**	**Cd**	**Pb**
CP	12.1	16.7	12.8
PP	14.1	10.17	18.1
MP	15.9	13.96	15
30h Milled	**Cr**	**Cd**	**Pb**

3 M			
CP	2.8	7.6	15.1
PP	3.06	10.1	16.1
MP	6.13	11.2	18.6

4- Heavy metal Initial Concentration

Biosorption capacity of the biomass increases with increasing initial concentration of the metal ions till up to optimum concentration. In this study, 5 different concentrations were selected (10 , 50 ,100 ,250 ,500) The highest adsorption rate for cadmium was 99.79% in 10ppm for banana peel .The highest adsorption of chromium was 99.63 % in 10ppm The highest adsorption of the lead element was 98.99% in 250 ppm .On the Table (4) and Shows initial Concentration of each element. This phenomenon can be attributed to an increase in electrostatic interactions involving sites of progressively lower affinity for the metal ions up to the point of saturation (Arshadi et al ., 2014; Meitei and Prasad., 2014). This in agreement with our results which showed that the percentage removal of the Cd and Pb ions decreased gradually markedly with an increase in the initial concentration of the metal ions from 125 to 200 ppm.

This might be due to the rapid saturation of all metal binding active sites of the biosorbent at a certain high concentration of the metal ions (Meitei and Prasad. 2014; Al-Homaidan et al.,2014). The ions remained in solution without adsorption due to the lack of sites because all the sites have been associated with ions. In the current study an equilibrium state between adsorbate and biosorbent was attained at (1- 40) min and at optimum concentration is 100 ppm as showed in tables(4) of Pb,Cd , pb respectively, the study of (Abdulla, 2017) which used different concentration 25 , 50 ,75 ,100 ,125 , 150 , 175 ,200 The absorption capacity increases with the initial concentration of the metal ions increases until the optimum concentration is reached. These results showing the percentage of the removal of ions that decreased with increasing concentration of the ions from the metal ions due to the rapid saturation of all the binding sites of the metals.

Table (4) : Initial Concentration of heavy metals Cr, Cd ,Pb

Adsorption	**Cr %**	**Cd %**	**Pb %**
CP	90.7	**91.15**	89.4
PP	85.9	84.9	81.3
MP	87.8	86.3	85.3
Adsorption	**Cr %**	**Cd %**	**Pb %**

CP	**97.4**	89.4	96.4
PP	94.6	87.9	95.3
MP	93.5	86.3	93.9
Adsorption	**Cr %**	**Cd %**	**Pb %**
CP	87.9	83.3	87.2
PP	85.9	**89.83**	81.9
MP	84.1	86.04	85
Adsorption	**Cr %**	**Cd %**	**Pb %**
CP	**97.2**	92.4	84.9
PP	96.94	89.9	83.9
MP	93.87	88.8	81.4

4- Conclusion

The result agree with (Shartooh, 2012) which used different heavy metals of concentration 5 ,10 ,50, 100 ,250 , 500 , 1000 The absorption capacity increases with the initial concentration of the metal ions increases until the optimum concentration is reached. According to Langmuir, 1916, we found the Maximum adsorption corresponds to a saturated monolayer of adsorbate molecules on the adsorbent in surface pomegranate and corn peels and mix and energy of adsorption have been constant with no transmigration of adsorbent in the plane of the surface area. Experiment of Reuse of powder to make sure of the effectiveness of peels have been used to re-adsorption experiment at once, and twice more time with the test only element Chrome to re-experience it was used for removal of elements from wastewater, the highest percentage of adsorption in corn peels and the benefit of the experiment to detect the effective use of the powder more than once and the highest absorption rate was 89.7%. The same procedure was used in Colom experiment with all the factors pH and 100 µm Cr concentration of the solution were identified for the effective removal of Cr elements.

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