Al-Khwarizmi Engineering Journal

Al-Khwarizmi Engineering Journal, Vol. 6, No. 4, PP 31 - 36 (2010)

The Biosorption of Cr (VI) From Aqueous Solution Using Date Palm Fibers (Leef)

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(Received 11 January 2010; Accepted 5 January 2011)

Abstract

The ability of Cr (VI) removal from aqueous solution using date palm fibers (leef) was investigated .The effects of pH, contact time, sorbets concentration and initial metal ions concentration on the biosorption were investigated.

The residual concentration of Cr (VI) in solution was determined colorimetrically using spectrophotometer at wave length 540 nm .The biosorption was pH-dependent, the optimum pH was 7 and adsorption isotherms obtained fitted well with Langmuir isotherms .The Langmuir equation obtained was Ce/Cs = 79.99 Ce-77.39, the correlation factor was 0.908.These results indicate that date palm fibers (leef) has a potential effect for the uptake of Cr (VI) from industrial waste water.

Keywords: *Adsorption, biomass, recycling of biomass, hazardous waste treatment*.

1. Introduction

Biosorption technologies utilize any natural form of biomass, to passively sorbs and immobilize solubilized heavy metal ions (1).

Biosorption is propriety of certain types of in active, dead biomass to bind and accumulate heavy metals from even every pathways of up take (2).

Rapid industrialization has led to increased disposal of waste water into the environment, the discharge of chromium (VI) into aquatic ecosystem has become a matter of concern in all the tannery areas. This pollutant introduced into the aquatic systems significantly from the effluents of leather processing units as a result of chrome tanning of leather.

The removal of heavy metal ions of industrial waste water using plant, animal and microorganisms materials receiving much attention because of cheap cost of treatment.

Different plant materials have been used in the biosorption of heavy metal ions from solution (3, 4, 5, and 6).

The choice of chrome of this study was made as a result of the carcinogenicity of this element as well as skin ulceration and allergic contact dermatitis in the exposed people (7).

The removal of Cr (VI) from aqueous solution under different conditions using an adsorbent was investigated; the biosorption potential was depended on the pH value, initial concentration of both sorbet and pollutant as well as the contact time.

2. Materials and Methods

2.1. Materials

Dry fibers of date palm rinsed with distilled water; sun dried and cut into pieces of approximately 0.5 cm, the dead tissues sample was kept dry till the time of usage. Potassium dichromate ($K_2Cr_2O_7$) was used as a source of Cr (VI) for the study.

A stock solution of 1000 mg/L was prepared from dissolving 2.828 gm in one liter of double distilled water.

2.2. Equilibrium Contact Time

All experiments were carried out in 0.5 L round plastic bottles in duplicate, containing 2 gm of date palm fibers with 100 mg/L of Cr (VI) dissolved in 100 ml double distilled water .The initial pH value of heavy metal ions solution was 5.6, for chemical analysis 1 ml sample was taken out from each bottle at different time (1, 2, 3, 24 and 48) hrs. The final concentration of Cr (VI) in each test analyzed colorimetrically by using Kirkuk spectrophotometer at 540 nm wavelength according to (8) figure (1).

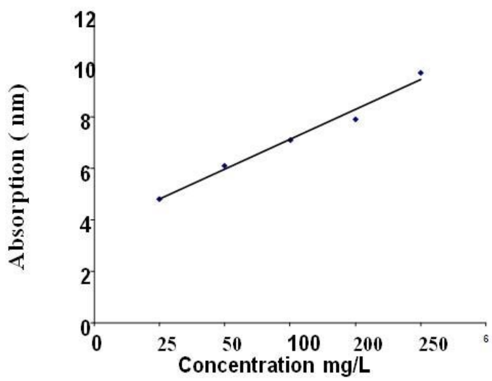

Fig.1. Standard Curve of Chrome.

2.3. Effect of Initial PH on Adsorption Capacity

All experiments were conducted in 0.5L round plastic bottles containing 1 gm (dry weight) of date palm leaves (carab) .each bottle contained 100 ml of heavy metal ions solution of Cr (VI) with concentration 100 mg /L .Five levels of initial pH (4,5,6,7 and 8) were maintained in the solution .

The residual concentration of heavy metal ions have been analyzed calorimetrically at different time (1, 2,3,24 and 48) hrs respectively .The amount of metal ions biosorbed from solution was determined by difference in concentration .The removal efficiency of Cr (VI) was calculated as:

Removal% = 100 (Ci-Ce)/Ci

Ci = the initial metal ion concentration (mg/ml)

Ce = the equilibrium metal ion concentration (mg/ml)

2.4. Effect of Biosorbent Dosage on Biosorption of Cr (VI)

The experimental procedure described previously was followed by using different amounts of date palm leaves (carab) (1, 2, 3, 4 and5) gm dry weight of each one at optimum pH (5).

3. Result and Discussion

3.1. Effect of Contact Time on Biosorption of Cr (VI)

The result of the effect of contact time is shown in figure (٢1), it is observed that the adsorptive capacity of date palm fibers (leef) increased with increase in contact time.

The biosorbtion was rabid for the first hour as a result of available binding sites on the biomass while the equilibrium time expanded to the 48th hour figure (2), the biosorption of metal ions reported to be biphasic (9), the fast one occurs due to surface adsorption on the biomass while the slow phase due to diffusion of the metal ion into the inner part of the biomass (9).

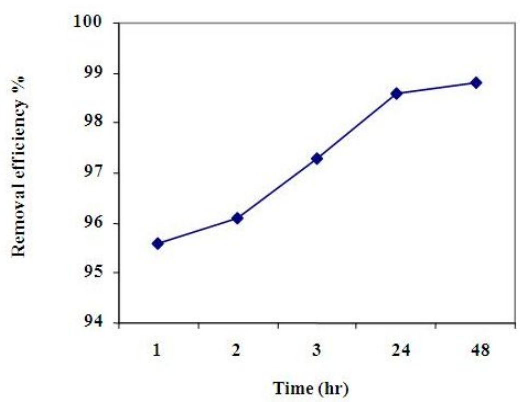

Fig.2. Effect of Contact Time on the Biosorption of Cr (VI) by Date Palm Fibers (Leef) at 25 ºC and Initial Metal Ion Concentration of 100 mg/ml.

3.2. Effect of pH on Biosorption of Cr (VI)

The effect of pH of Cr (VI) Solution on the removal efficiency was studied by varying the initial pH under constant process parameters. The result was shown in figure (3).The maximum biosorption was obtained at pH 7, this result supports that the biosorption is pH dependent (10). Surface adsorption is a physiochemical phenomenon and the cell walls of many plants contains several of compounds such as polysaccharide, proteins, lipids have ability to bined to heavy metals by their functional groups (amine, carboxyl, sulphydryl, phosphate and thiol) these groups have different affinity and specificity for metal binding (9).

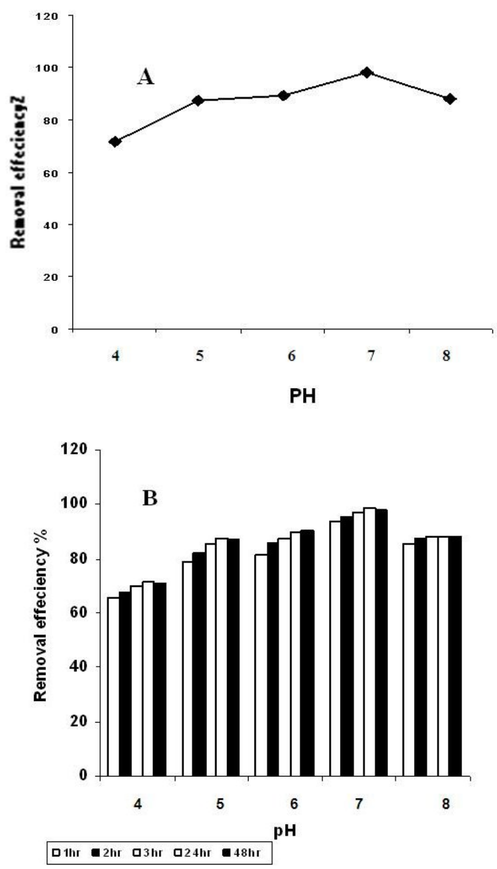

Fig.3. Effect of PH Value on the Biosorption of Cr (VI) by Date Palm Fibers (leef) at 25 ºC and Initial Metal Ion Concentration of 100 mg/ml; A) at Equilibrium Time. B) at Different Time.

3.3. Effect of Initial Concentration of Cr (VI) on Biosorption

The effect of initial concentration of Cr (VI) on biosorption was shown in figure (4), the removal efficiency was increased according to the concentration of Cr (VI) which was reached to 95.2 % at the first hour at 25 mg/L of Cr (VI).The result indicates that the leef has a potential to be used as a cost –effective biosorbent for removal of heavy metal ions from solutions with low concentrations.

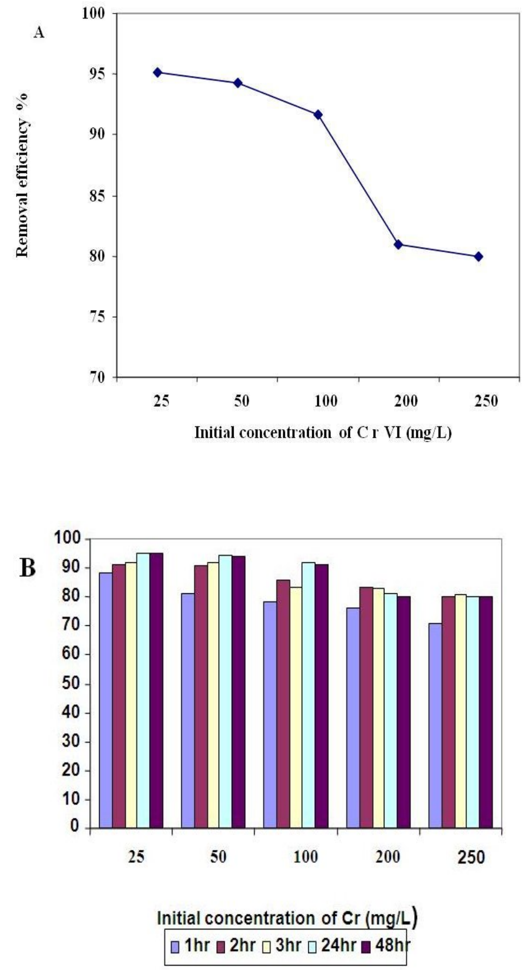

Fig.4. Effect of Initial Concentration of Cr (VI) on the Biosorption of Cr (VI) By Date Palm Fibers (leef) at 25 ºC and Initial Metal Ion Concentration of 100 mg/ml; A) at Equilibrium Time. B) at Different Time.

3.4. Effect of Biosorbent Dosage on Biosorption of Cr (VI)

The removal efficiency of Cr (VI) at different date palm leaves doses is shown in figure (5). It can be seen that the removal efficiency of Cr (VI) increases and reaches a maximum value 98.7% at 5 gm of date palm leaves at 48 hrs.The increase in removal efficiency may be related to the fact that the number of available adsorption sites increases by raising the adsorbent doses and that causes the increase of Cr (VI**)** removal efficiency.

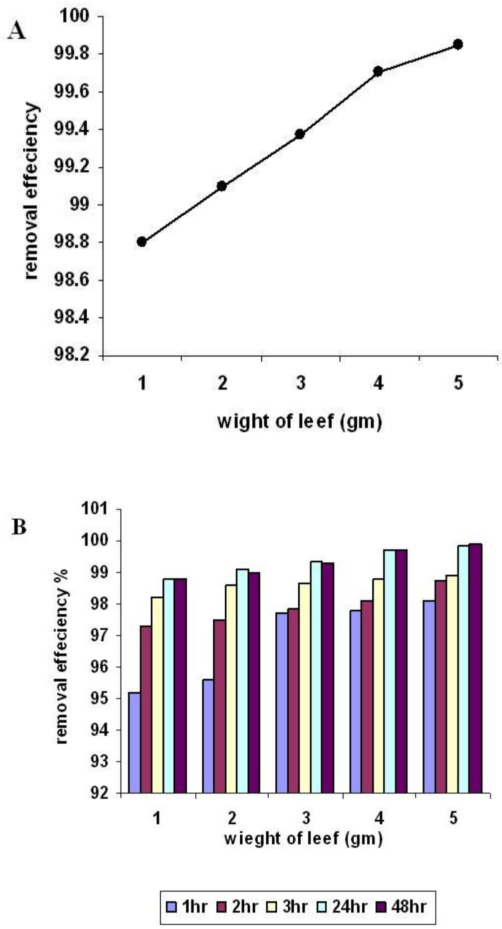

Fig.5. Effect of Initial Dose of Date Palm Fibers (leef) on the Biosorption of Cr (VI) at 25 ºC and Initial Metal Ion Concentration of 100 mg/ml; A) at Equilibrium Time. B) at Different Time.

3.5. Adsorption Isotherm

Figure (6) represent the adsorption Langmuir isotherm of Cr (VI) on date palm leaves. The adsorption isotherm shows good agreement with the typical Langmuir isotherm plot, the adsorbent completely based on the assumption that a single monolayer of Cr (VI) accumulate at the solid phase. According to Langmuir data that date palm leaves are an effective adsorbent for Cr (VI).the correlation coefficient was found to be 0.908, the equation that describes that Langmuir system is represented by equation (1) and it's linerized from equation (2) (11).

$$Ce = \frac{X}{M} = \frac{ab\,Ce}{1+bCa} \qquad \ldots(1)$$

$$\frac{Ce}{M/X} = \frac{1}{ab} + \frac{1}{a}Ce \qquad \ldots(2)$$

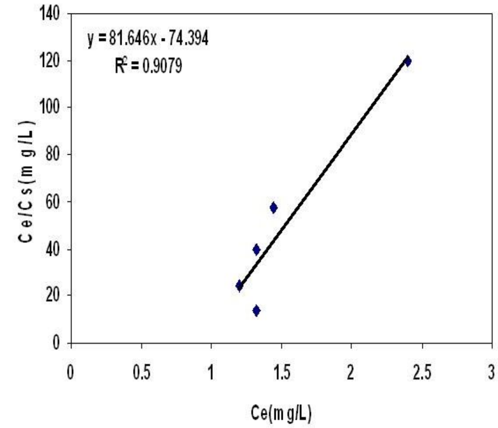

Fig.6. Langmuir Isotherm for the Biosorption of Cr (VI) by Date Palm Fibers (Leef).

Table 1,
Langmuir Adsorption Constants for Adsorbent Material.

Laongmuir Parameters		
a	b	R
12.25	1.097	0.908

4. References

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الامتصاص الحيوي لايونات الكروم سداسية التكافؤ من المحلول المائي بأستخدام الياف نخيل التمر

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الخلاصة

ركزت الدراسة الحالية على قدرة الياف نخيل التمر في ازالة ايونات الكروم سداسية التكافؤ Cr (VI) من المحلول المائي. تضمنت الدراسة تأثير الدالة الحامضية , زمن التعرض , تركيز المادة النباتية الممتزة اضافة الى التركيز الاولي لايون الكروم سداسي التكافؤ Cr (VI) على قابلية الياف النخيل في ازالة هذه الايونات من المحلول المائي .تم قياس تركيز ايون الكروم المتبقي في المحلول لونيا باستخدام جهاز المطياف عند طول موجي ٥٤٠ نانو ميتر.

اعتمدت عملية الازالة على تركيز ايون الهيدروجين في المحلول حيث وجد ان الدالة الحامضية المثلى التي اعطت اعلى نسبة ازالة لايون الكروم سداسي التكافؤ كانت 7 وتوافقت معادلة التكافؤ الحراري مع معادلة Langmuir وكانت بالشكل $Ce/Cs = 79.99Ce-77.39$ في حين ان معامل الارتباط بلغ 0.908, من نتائج الدراسة وجد ان كفاءة الياف نخيل التمر في ازالة عنصر الكروم من المحلول كانت عالية بلغت 98.6% عند زمن الاتزان Equilibrium time.
