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Removal of Heavy Metals From Waste Water By Date Palm Tree Wastes

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Abstract

Wastes of the Iraqi date palm tree was used to study removal of heavy metal cations (Cu^{+2}, Cd^{+2}& Zn^{+2}) from simulated artificial waste water using batch adsorption process.

The dried parts of the date palm wastes, were grinded to ≤1mm in size and used directly in different adsorbent / metal ion ratios, starting with metal ion concentration of (1000ppm).

Influence of contact time, initial metal ion concentration, and adsorbent loading weight, on removal percentage were investigated; experiments were carried out at room temperature. 25C^{o} and pH value of (5-6).

Date palm wastes succeeded to achieve 90% removal for Cu^{+2} ions, 57.5% for Cd^{+2} ions & 37.5% for Zn^{+2} ions within (60 min) contact time at adsorbent loading ratio of 30 g/l. Removal values for mixed ions were lower due to competition &interaction between ions, (80% Cu^{+2}, 51% Cd^{+2} & 33% Zn^{+2})

Keywords :- Adsorption, Heavy metals, Waste water, Date palm tree

ازالة العناصر الثقيلة من المياه باستخدام مخلفات نخلة التمر العراقية

الخلاصة

تم تجربة استخدام مخلفات نخلة التمر العراقية المتوفرة محليا كبديل لامتزاز ايونات المعادن الثقيلة الملوثة للمياه , حيث تم طحن الاجزاء اليابسة من مخلفات النخلة الى قياس ≥ 1 ملم ثم استخدم المسحوق لامتزاز محاليل محضرة مختبريا لايونات كل من (النحاس , الزنك و الكادميوم) بتركيز (1000) جزء بالمليون , اظهرت النتائج نجاح المادة المستخدمة , حيث ازالت (90 % من ايونات النحاس, 57.5 % من ايونات الكادميوم , 37.5 % من ايونات الزنك) بعد اضافتها الى المحاليل الملوثة بمدة ساعة واحدة مع الرج وتحت ظروف pH (5-6) ودرجة حرارة الغرفة (25 م°) , وكانت احسن نسبة للمادة المستخدمة هو بتركيز (30 غم / لتر) من المحاليل الاحادية وعند استخدام نفس الظروف على المحاليل المختلطة الثنائية والثلاثية كانت نسبة الازالة اقل قليلا من المحاليل المفردة الايون , بسبب تاثير التداخل والتنافس بين الايونات

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Introduction

Removal of heavy metals (which are important toxic pollutants) from wastewater by adsorption is an efficient process. Activated carbon is widely used as an adsorbent due to its high adsorption capacity. Because of its high prices, alternatives are being seeked for. Agricultural products and waste by products have been investigated in many previous studies which have been recognized as a potential alternative to it. Adsorption is the best alternative to the conventional technologies such as precipitation[1]; ion exchange[2], solvent extraction[3] and membrane[4], for removal of heavy metals from industrial wastewater ,because these process have technical and /or economical constraints.

Sung Ho Lee, etal,[5] made experiments to investigate the removal characteristics of copper, lead and cadmium from aqueous solution by apple residues in packed column. The cation exchange capacity of the original apple residue was modified by chemical treatment with phosphorus (V) oxychloride. Metal removal capacity by phosphated apple residues was three to four times higher than that by apple residue in the removal of capper and lead .

Adeyinke Adeyiga, et al,[6] worked on removal of priority metal ions, such as lead, nickel, and Zink from wastewater by using tree leaves. Twelve different kinds of tree leaves were tested at room temperature, experiments were carried out with 2gm of (40-50) mash leaves in (200 ml) synthetic wastewater containing about 50ml/l metal ions. Initial pH of the synthetic wastewater was about 5. Experiments showed highest removal rate of 96% for lead Pd^{++}, 61.75% for Nickel Ni^{++} and 71% for Zink Zn^{++}.

Removal of cadmium, lead and nickel from industrial wastewaters has been investigated by Amir Hossein Mahvi and others [7], using tea waste as natural adsorbent in bench scale experiments, using different amounts of adsorbent in solutions with different concentrations of each metal and in mixed combination. Results indicate that the removal efficiency is highest for lead 94% and is minimum for cadmium 77.2% and 85.7% Ni, using 0.5g/l adsorbent for solutions having concentration of 5mg/l mixed solutions . For mixtures of metals, results were lower by 3.5 % for Pb, 13.2% for Ni (5mg/l mixed solution).

Nile rose plant was used by N.T.abdul Ghani, [8] to study adsorption of (Cu^{+2}, Zn^{+2}, Cd^{+2} & Pd^{+2}) from waste water within various experimental conditions. Influence of pH, contact time, metal concentration and adsorbent loading weight on removal process were investigated. Batch adsorption studies were carried out at room temperature. Adsorbent efficiencies were found to be pH dependant.

Equilibrium time was attained within (60-90min) and maximum removal percentage was achieved at an adsorption loading of (1.5 g/50 ml) mixed ions solution. The removal order was to be (Pb^{+2}> Zn^{+2}> Cu^{+2}> Cd^{+2}), with values of 95-100% for Pb, 70 – 75% for Cu, Zn & Cd with initial concentration of 5 – 50 ppm

Naimah ibrahim,et.al [9] Studied using oil palm waste materials, as an adsorbent to hexavalent chromium ion from aqueous solution simulating electroplating effluent. Simple

chemical modification of the oil palm waste material had been made to enhance its adsorption capacity. Total removal of hexavalent chromium ions was achieved by oil palm fiber after being agitated for (2hrs) under influence of acidic PH.

Dr.Sndhya Babel [10] used pineapple wastes for removal of heavy metals from sludge. Naturally fermented raw liquid at 62.5 ml/gm dose & PH value of 3 – 4, have extraction efficiency of 34% Cd, 6% Cr, 100% Cu , 48% Pb , 38% Ni & 100% Zn.

The goal of this research is to develop inexpensive highly available, effective metal ion adsorbent from natural wastes as alternative to existing commercial adsorbents. Date palm tree wastes are available in large quantities and can be used widely as a low cost adsorbent for heavy metal removal.

Experimental work

Materials & Methods

A-Date palm tree wastes (by products). Dry wastes of the date palm tree were crushed and grinded then sieved to ≤ 1 mm in size and used directly as a natural adsorbent.

B-Preparation of Synthetic wastewater

Solutions of metal ions were prepared from analytical quality chemicals, and distilled water, as (1000 ppm) then by dilution to any required concentration .

For analysis of results, calibration curves were prepared for each ion of (Cu^{+2}, Cd^{+2} and Zn^{+2}) different concentrations of metal ions solution against the volume of (EDTA) required to reach the end point. [11] (Fig.2).

C. Chemicals used to prepare solutions were of analytical grade

Copper chloride 98% purity for Cu^{+2} ion solutions.

Zink chloride 98% purity for Zn^{+2} ion solutions.

Cadmium sulfate 98% purity for Cd^{+2} ion solutions.

D.Batch sorption experiments

Each metal ion solution was prepared by dissolving (1gm) of the salt of the desired ion in a liter of distilled water and kept for work. Adding the adsorbent in certain concentration shaking of solution for (1hour), then samples were taken, filtered and examined for metal ion removal, while the rest of mixture was kept for another period of (1hr) to be examined after, and so on.[12].

Percentage removal = $(C_i-C_f /C_i)*100$

C_i = initial metal ion concentration

C_f = final metal ion concentration

Results & Discussion

1. Date palm tree wastes were effective adsorbent to remove high metal ion concentrations up to 1000 ppm of Cu, Cd & Zn ions, from artificial waste waters at room temp. 25°c, pH values of (5-6), using adsorbent dose of 30 g/L.
2. Results (Fig 1) show that Cu ion posses similar percentage removal, when the adsorbent dose was decreased from 30 to 20 g/L, while Cd & Zn ions removal decrease by 13%, and 16% respectively.
3. Optimum contact time of adsorbent with single and mixed ions was 1 hr, since no further decrease in solution concentration took place.[Fig1].
4. Table (1) illustrates the metal ions percentage removal of binary and tertiary solutions; comparing

with results obtained with single metal ion solution, there was some decrease in percentage removal [Table 2]. This decrease increases with number of ion mixed.

This decrease in percentage removal is due to interaction and competition between mixed ions [13].

5. Calibration curves were used to analyse results, [Fig 2] metal ion concentration of solution samples was according to volume of EDTA used [11,12].

Conclusions

1. Crushed date palm tree wastes were cheap effective material used to adsorbed heavy metal ions from artificial waste water in the order Cu> Cd > Zn.
2. Percentage removal of Cu^{+2} was 90%, Cd^{+2} 57.5% & Zn^{+2} 37.5% , starting with 1000 ppm solution concentrations under acetic pH (5-6), room temp. of 25^{o}C using 30 g/L adsorbent dose.
3. Optimum contact time was 1hr, for all (ions single, and mixtures.
4. Percentage removal decreased Clearly with increasing mixed ions.

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Table (1) Mixed ion solution percentage removal (3% gm/ml) adsorbent, (25C°), (5-6 pH), (1hr contact time)

Mixed ion conc. 1000 ppm	Conc. ppm after (1 hr)	%removal
Zn^{+2}	650	35%
Cu^{+2}	125	87.5%
Zn^{+2}	645	35.5%
Cd^{+2}	420	58%*
Cu^{+2}	150	85%
Cd^{+2}	450	55%
Cu^{+2}	200	80%
Cd^{+2}	485	51.5%
Zn^{+2}	670	33%

Table (2) % removal for single, Binary and tertiary ions [at same conditions]

Metal ions % removal	Single ion	Binary ions	Tertiary ions
Cu^{+2}	90	85-87	80
Cd^{+2}	57.5*	55-58*	51
Zn^{+2}	37.5	35-35.5	33

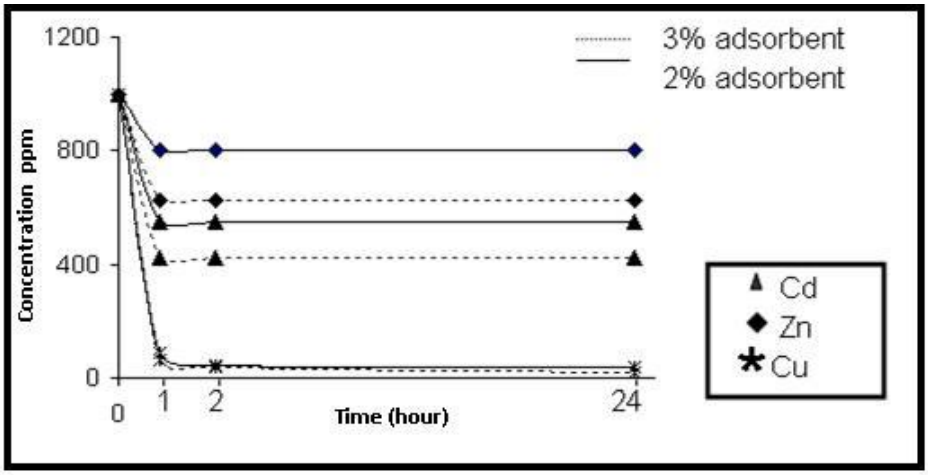

Figure (1) Adsorbent dose and contact time

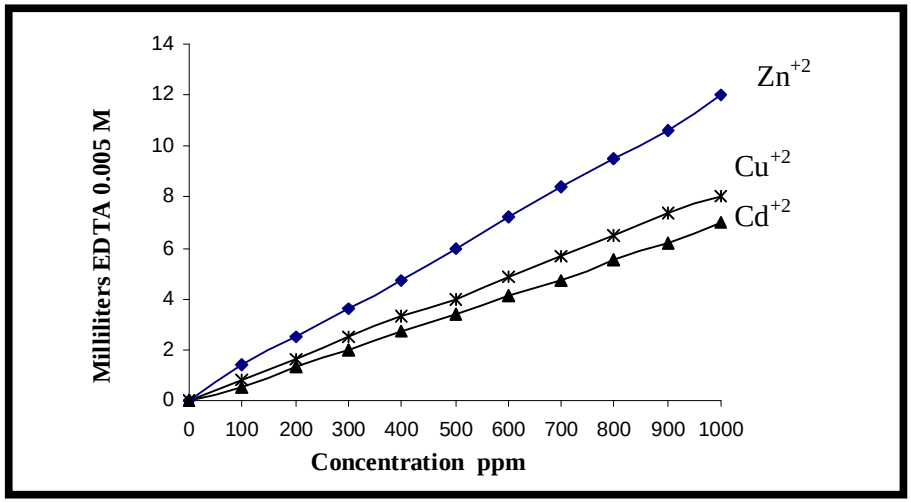

Figure (2) Calibration curves of solutions of heavy metal ions titrated with (0.005 M) EDTA