J. Egypt. Acad. Soc. Environ. Develop., 20 (1):47-60 (2019) **(D-Environmental Studies)**
E.mail: easedjournal_egypt@yahoo.com **ISSN 1110-8770**
www.jades.journals.ekb.eg **eISSN 2314-5471 (online)**

Removal of Fe^{2+} and Pb^{2+}ions from wastewater using rice husks-based adsorbents

Ahmed Abdel Halim[1], Khaled H. El-Ezaby[2], Maie I. El-Gammal[2] and Heba M. Saber[1*]
1- Marine Environment – National Institute of Oceanography and Fisheries
2- Environmental Sciences Department, Faculty of Sciences, Damietta Univ., Egypt
*Corresponding Author e-mail: Dr.heba_env@yahoo.com

ABSTRACT

There is an urgent need that all possible sources of inexpensive adsorbents should be explored and their feasibility for the removal of heavy metals. Thus, this study presents application of low-cost adsorbents agro-based wastes, such as rice husk and their utilization possibilities for elimination of heavy metals**;** Fe (II) and Pb (II) from wastewater by the adsorption process.The adsorption technique was used for the removal of Fe^{2+} and Pb^{2+} in two drains (Khashaa drain and Tera drain) which are discharged into Burullus Lake.

The obtained results showed that, the adsorption of the metal ions was adsorbent dosage, adsorbate concentration, contact time and pH dependent. The optimum contact time, adsorbent dosage, and pH were found to be at 105 min, 8 g and pH 8, respectively, for Fe^{2+} and at 40 min, 8 g and pH 8, respectively, for Pb^{2+}. Freundlich isotherm model was found to be the best fit most suitable for each of heavy metals at R^2= 0.96, 0.91. Kinetic studies showed that pseudo-second-order reaction model best described the adsorption process.The results revealed also a good removal of Fe^{2+} and Pb^{2+}using rice husk under optimum conditions with removal percentage 91.36% and 94.42% for Fe^{2+}, respectively and Pb^{2+} in Khashaa drain and 93.56% and 90.93% for Fe^{2+} and Pb^{2+}, respectively in Tera drain.

Therefore, the study showed that rice husk can be efficiently used as low cost alternative for removal of metal ions.

Key words: Heavy metals; adsorption process; rice husk.

INTRODUCTION

Heavy metals such as Pb, Cd, Cr, Ni, Zn, Cu and Fe are environmental priority pollutants and one of the most serious environmental problems. Heavy metal pollution occurs directly by effluent outfalls from industries, refineries and waste treatment plants and indirectlybythecontaminantsthatenterthewatersupplyfromsoil/groundwatersystemsand from the atmosphere via rain water (Ashruta *et al.*, 2014). Heavy metals from anthropogenic sources typically have a high bioavailability due to their soluble and mobile reactive forms (Ayangbenro and Babalola, 2017). The distribution of metals in the environment is governed by their properties and influences of environmental factors (Morais *et al.*, 2012; El-Amier *et al.*, 2016). They can be carried to places many miles awayfrom the sources by wind, depending upon whether they are in gaseous form or as particulates. Metallic pollutants are ultimately washed out of the air into the land or the surface of water ways, thus air is also a route for the pollution of environment (Mahurpawar, 2015).

As heavy metals are not biodegradable and their existence in receiving lakes and streams, they disrupted the natural biogeochemical cycles of metals causing increased deposition of the heavy metals in soils and aquatic ecosystems (Azimi *et al.*, 2017). Heavy metals cause bioaccumulation in living organisms, which lead to several health problems in animals, plants and human beings such as cancer, kidney failure, metabolic acidosis, oral ulcer, renal failure and damage in for stomach of the rodent (Mehmet *et al.*,2006).

Of the important metals, mercury, lead, cadmium and chromium (VI) are regarded as toxic; whereas, others, such as iron, copper, nickel, cobalt and zinc are not as toxic, but their extensive usage and increasing levels in the environment are of serious concerns (Nagajyoti *et al.*, 2010).

Many wastewater treatment processes have been developed to remove heavy metal ions; these methods include chemical precipitation, ion-exchange, adsorption, membrane filtration, electrochemical treatment technologies (Zhang, 2014), chemical oxidation or reduction, evaporation, filtration, reverse osmosis, electro deposition, coagulation (Das *et al.*, 2008), sedimentation, cementation, flocculation, solvent extraction (Swathi *et al.*, 2014), electrodialysis, ultrafiltration, photocatalysis, complexation and foam floatation (Gunatilake, 2015).The choice of method for wastewater treatment is based jointly on the concentration of heavy metals in solution and the cost of treatment.

Conventional methods for metal ions removal from wastewater are limited by technical and economic barriers. Comparing adsorption to other conventional treatment methods, adsorption is considered as an economical, versatile and favorable technology for heavy metal removal from wastewater due to low cost, metal selectivity, stability, utility, regenerative, absence of toxic sludge generation, low fouling problems, metal recovery, flexibility and simplicity of design, ease of operation, insensitivity to toxic pollutants and efficiency (Hussein *et al.*, 2004; Dixit *et al.*, 2015; Ince and Ince,2017).

Recently efforts have been made to use cheap and available agricultural wastes such as coconut shell, orange peel, rice husk, peanut husk and sawdust as adsorbents to remove heavy metals from wastewater (Bernard *et al.* 2013; Gervas *et al.* 2015; Sudha and Premkumar, 2016). Biosorption is promising techniques for the removals of heavy metals from aqueous environments especially when adsorbents are derived from lingnocellulosic materials**,** rice husks are an agricultural waste substance, structurally, consist of cellulose, hemicellulose, and lignin (Coelho and et al., 2007).

Therefore, the aim of this study was to find out the effectiveness of low-cost adsorbents agricultural by-products and residual wastes, such as rice husk and their utilization possibilities for the elimination of heavy metals**;** $Fe^{2+}$and Pb^{2+} ions from Burullus Lake wastewater.

METHODOLOGY

In this study, the adsorption behavior of heavy metal ions; lead (Pb) and iron (Fe) was carried out by batch method at optimum conditions, including pH, contact time and various adsorbent amounts.

1. Adsorbent Preparation "Rice Husk"

The rice husk was obtained from a field at Damietta governorate. The husks were washed carefully with tap water and then deionized water to remove particulate material from their surface. After that, they were dried in an oven at 100 ºC for 24 hr. The concentrations of the investigated metal ions in the filtrates were determined according to **APHA (1999)** by atomic absorption spectrophotometer(AAS), after preconcentration by extraction with ammonium pyrrolydine dithiocarbamate (APDC) and methyl isobutyl ketone (MIBK).

2. Batch Adsorption Experiments

The adsorption experiments were carried out under batch operation mode at a constant temperature of 25 °C, and on 10, 25, 50, 75, and 100 µg/l of the investigated metal ionsfor the removal of lead (Pb) and iron (Fe)ions.In all sets of experiments, 2 gm of adsorbent was accurately weighted in 250 ml conical flask, and 50 ml of the corresponding heavy metal in aqueous solution was added. The system was properly shaken by magnetic stirrer for 30 minutes at 240 rpm to study the effect of parameters (sorbent dosage, pH, concentration, temperature and contact time). After filtration through the filter paper, Fe^{2+} and Pb^{2+} ions remaining in wastewater, determined by AAS.

-The amount of metal ion adsorbed was calculated as:

$$q_e = v\ (c_i - c_e) / m$$

Where qe is the amount of heavy metals taken by adsorbent (mg/g), C_i and C_e are the concentrations of heavy metals at initially and equilibrium (mg/l), V is the volume of solution (l) and M is the mass of adsorbent(g).

-The removal efficiency is calculated as:

$$\%\ Removal = (c_i - c_f / c_i) * 100$$

Where; C_i and C_e are the initial and final heavy metals concentration (mg/l).

a. Adsorption Isotherm

Equilibrium in heavy metals; Fe^{2+} and Pb^{2+} adsorption was modeled by isotherms such as Langmuir, Freundlich and Temkin model. Correlation coefficient (R^2) values show the feasibility of using isotherm models which is calculated from fitting of equilibrium adsorption data by these models.

-Equilibrium adsorption capacity of heavy metals (µg/g) was calculated by Banerjee and Chattopadhyaya (2013):

$$q_e = v\ (c_i - c_e) / m * 10^{-3}$$

Where, C_e and C_i are the concentrations of heavy metals at equilibrium and initially (µg/l), V is the volume of solution (ml), M is the mass of dry adsorbent (g).

c.Investigated Samples in Burullus Lake wastewater

Two sub-surface samples were collected from two drains; Khashaa and Tera in Burullus Lake wastewater before its discharged Points. Water samples were collected using Niskin bottle in high density polyethelene (HDPE) bottles that were routinely acid treated with a solution (0.5 N HCl) and well-rinsed with de-ionized water prior to use, dried, and stored with the caps on to prevent contamination. The bottles were rinsed with sample water prior to actual sample collection, then transferred using ice box to the laboratory.

Application of rice husk as adsorbent of Fe^{2+} and Pb^{2+} ions from two drains; Khashaa and Tera in Burullus Lake wastewater was investigated by batch method by adding 50 ml of the corresponding sample and applying the optimum conditions (8 g of the adsorbent, pH 8 for $Fe^{2+}$and 8 g of the adsorbent, pH 8 for Pb^{2+}). The system was properly shaken by magnetic stirrer for 105 min for Fe^{2+}treatment and 40 min for Pb^{2+}treatment at 240 rpm. After filtration through the filter paper, Fe^{2+} and Pb^{2+} ions remaining in wastewater, determined by AAS.

RESULTS AND DISCUSSION

a. Characterization of Rice Husk

Fourier transform infrared (FTIR) spectrometer was obtained to characterize surface functional groups of rice husk before and after adsorption process. Figs (1, 2 and 3) represent Fourier transform infrared spectrum of rice husk which compared with IR spectrum of heavy metals; Fe^{2+} and Pb^{2+}sorbed species. The bands absence and appearance of other bands were taken as a strong evidence for adsorption process for Fe^{2+} andPb^{2+}.

The surface morphology of rice husk before and after adsorption was visualized using scanning electron microscopy (SEM). Fig (4.a) indicated a heterogeneous, rough, and groove-like morphology. In addition, many pores on the surface of rice husk were observed. Heavy metals; Fe^{2+} and Pb^{2+} adsorbed on rice husk surface the progressive changes and the presence of new uneven bulky particles over the surface which were absent before loading the heavy metals. Many pores were also present on surface of adsorbent which favor adsorption of heavy metals (FigS. 4, b and c).

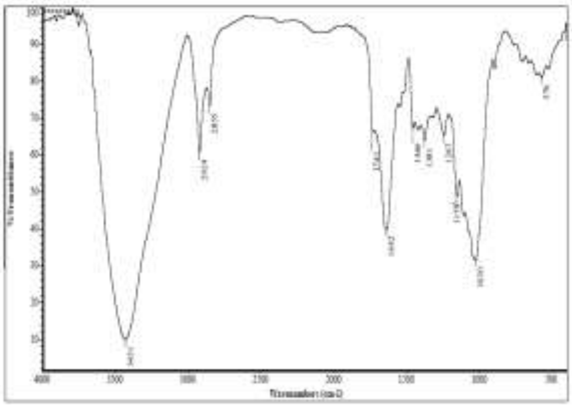


Fig (1): FTIR for rice husk.

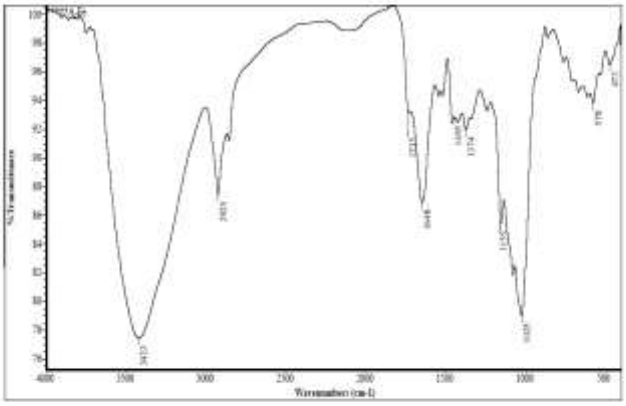


Fig (2): FTIR for rice husk after adsorptionofFe^{2+}

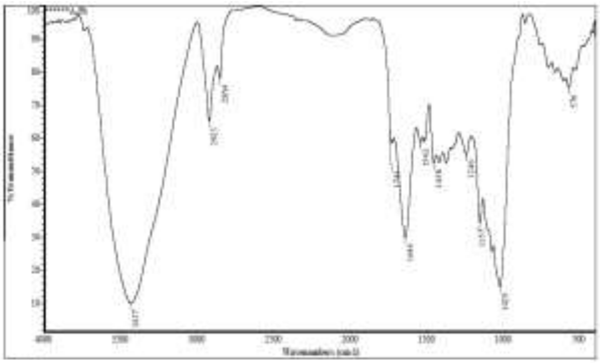


Fig (3): FTIR for rice husk after adsorption ofPb^{2+}

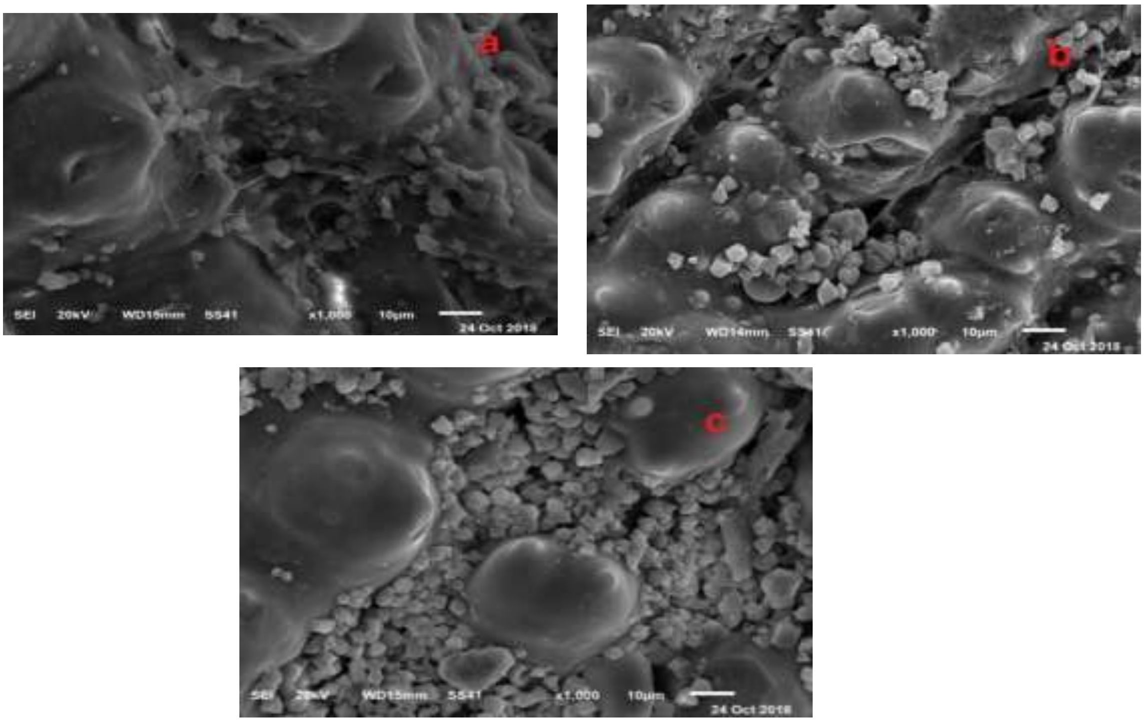


Fig (4.a): SEM of rice husk before adsorption, Fig (4.b): SEM of rice husk after adsorption of Fe^{2+} and Fig (4.c). SEM of rice husk after adsorption of Pb^{2+}

b. Effect of Various Parameters on Adsorption by Rice Husk

It was found that; rice husk showed high efficiency for the sorption of the investigated metals; Fe^{2+} andPb^{2+} ions under the optimum work conditions. This was most probably due to the strong interaction between metal ions and active functional groups inside rice husk. In order to obtain quantitative recoveries of the metal ions on rice husk, the pre-concentration procedure was optimized for various analytical parameters such as contact time, pH, the amount of rice husk, temperature and initial heavy metals concentration.

i. Effect of Contact Time

Effect of contact time on the rate of adsorption using rice husk, was achieved, the removal of each of Fe^{2+} and Pb^{2+} by adsorption was showed to increase with increasing time and attained a maximum value at about 105 min and 40 min for Fe^{2+} and Pb^{2+}, respectively, and then it remained almost constant (Fig , 5 and 6). The adsorption was very rapid initially and large amount of Fe^{2+} and Pb^{2+}removal in first 30 min at different five concentration from 10- 100 μg/l.

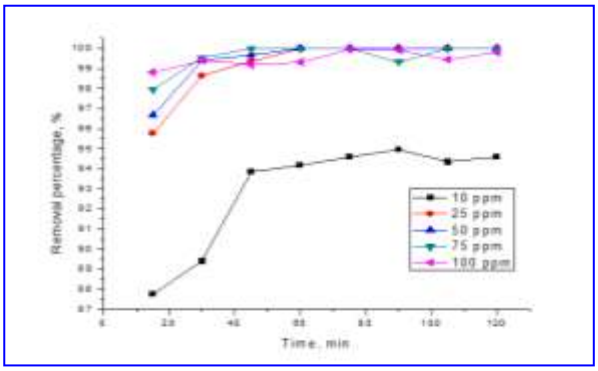


Fig (5): Effect of contact time on adsorption of Fe^{2+} on rice husk.

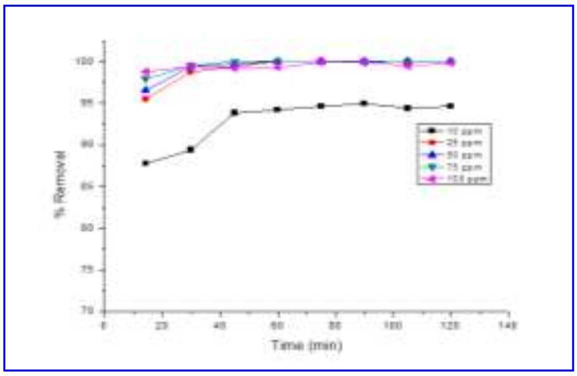


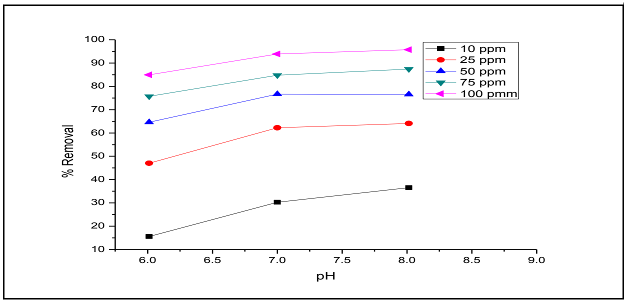
Fig (6): Effect of contact time on adsorption of Pb^{2+} on rice husk.

ii. Effect of pH

The pH of the wastewater is one of the imperative factors governing the adsorption of the metal ions. Effect of pH on the adsorption of Fe^{2+} and Pb^{2+} studied in the initial pH range from 6-8. The relation between initial pH of solution and percentage removal of these heavy metals is shown in Figures (7 and 8). The variation in adsorption capacity in this pH range was largely due to the influence of pH on the adsorption characteristics of Fe^{2+} and Pb^{2+}which indicated that the adsorption capacity of the adsorbent was clearly pH-dependent. The optimum pH was observed with removal at pH 8 approximately at percentage removal 95.76% and 100% for Fe^{2+} and Pb^{2+}, respectively by rice husk.

At higher pH value, Fe^{2+} and Pb^{2+}removal increased, due to electrostatic attraction between places with negative charge on surface of adsorbent rice husk and each of heavy metals. Thus, the heavy metals surface interaction dominated.

With increase of pH, the number of hydrogen ions in solution decreased. Furthermore, the competition for heavy metal ions decreased too and the sorption was more efficient (Malgorzata and Lidia, 2014).



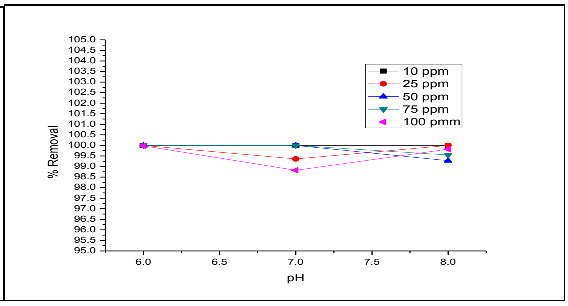


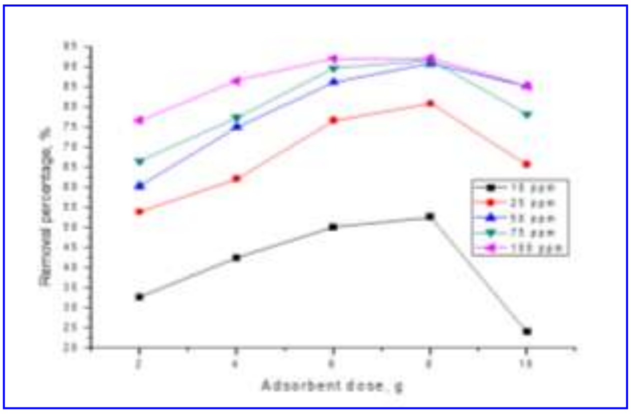
Fig (7): Effect of pH on adsorption of Fe^{2+} by rice husk

Fig (8): Effect of pH on adsorption of Pb^{2+} by rice husk

iii. Effect of Adsorbent Dose

The variations of dose from 2- 10 g for adsorbent are graphically represented in Figures (9 and 10). The mass seemed to exert an important influence on the adsorption process. The optimum dose was observed with removal at 8 and 8 gm at percentage removal 92.1% and 100% for Fe^{2+} and Pb^{2+}, respectively by rice husk. It can be clearly seen that when adsorbent dosage increased the percent removal of heavy metals by rice husk increased due to increased surface area and active sites (Padmavantly *et al.*, 2016).

For Fe^{2+}, when dosage was more than 8, an inverse relationship was due to aggregation of particles and the surface area would be decreased. For Pb^{2+}, when dosage was more than 2, an inverse relationship was due to aggregation of particles and the surface area would be decreased.



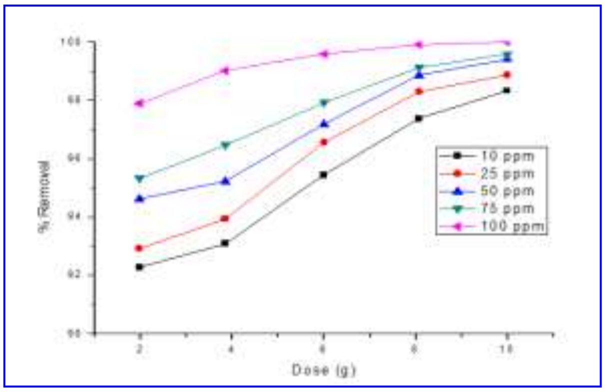


Fig (9): Effect of adsorbent dosage on adsorption of Fe^{2+} by rice husk

Fig (10): Effect of adsorbent dosage on adsorption of Pb^{2+} by rice husk

iv. Effect of Initial Concentration

Effect of concentration on the adsorption rate was investigated in conditions at room temperature = 25ºC, for Fe^{2+} and Pb^{2+}, respectively, and shaking speed 240 rpm which are represented in Figures (11 and 12).

The effect of initial heavy metals concentration was studied in the range (10- 100 μg/l). It was observed that percentage removal decreased with increasing in initial heavy metals concentration. This result was due to the saturation of available active sites on rice husk above a certain concentration of heavy metals.

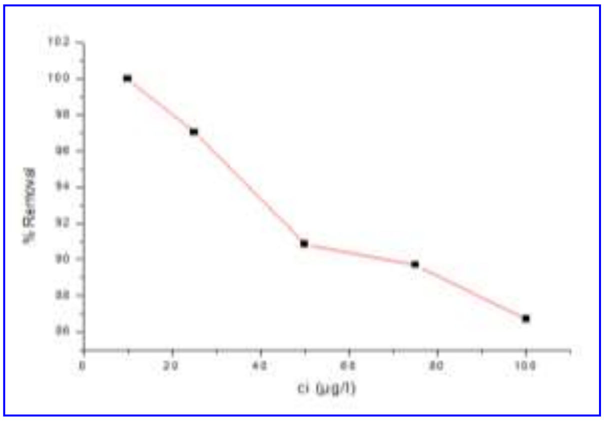


Fig. (11): Effect of initial concentration on adsorption of Fe^{2+} by rice husk.

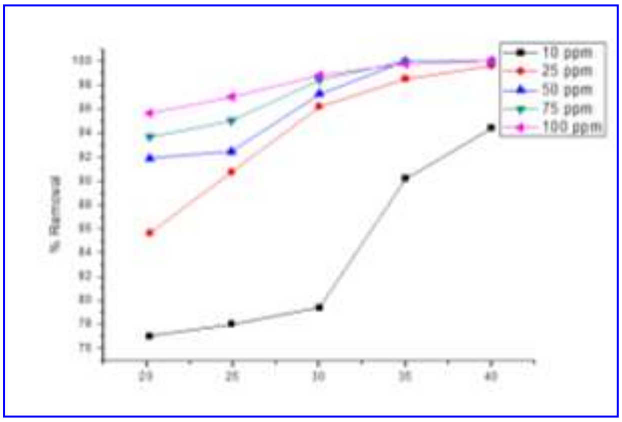


Fig. (12): Effect of initial concentration on adsorption of Pb^{2+} by rice husk.

v. Effect of Temperature

The influence of temperature on Fe^{2+} and Pb^{2+} retention onto the adsorbent was investigated in temperature range of 20-40°Cfor rice husk. Thermodynamic parameters are dependent on temperature which indicates if the adsorption is exothermic or endothermic. When the temperature of the system was increased, the adsorption of Fe^{2+} decreased (Fig13).This was mainly due to decrease in the surface activity in which heavy metals adsorption is an exothermic process for rice husk adsorbent. When temperature of the system increased, the rate of adsorption of Fe^{2+} and Pb^{2+}increased with that indicated the adsorption (Fig.14).

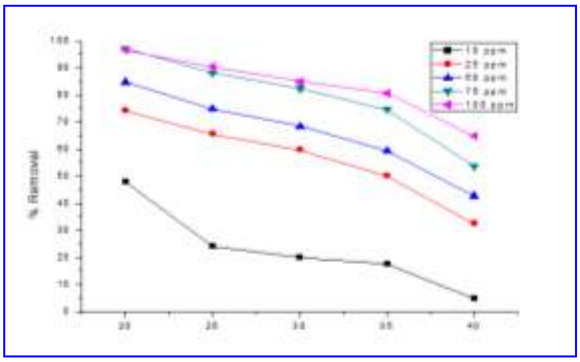


Fig (13): Effect of temperature on adsorption of Fe^{2+} by rice husk

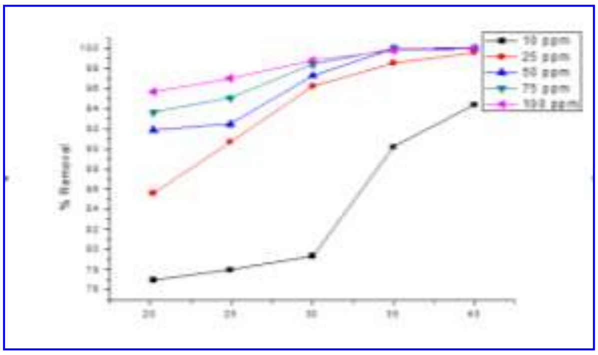


Fig (14): Effect of temperature on adsorption of Pb^{2+} by rice husk

3.3. Adsorption Isotherm for RiceHusk

Adsorption isotherm indicates the distribution of liquid and solid phases at equilibrium. The analysis of the equilibrium data by fitting them to different isotherm models is an important step to find a suitable model that can be used for design purpose. Fig (15 and 16) show the relation between the value of equilibrium concentrations of adsorbate (c_e), and amount of the adsorbed at equilibrium (q_e) for Fe^{2+} and Pb^{2+}, respectively.

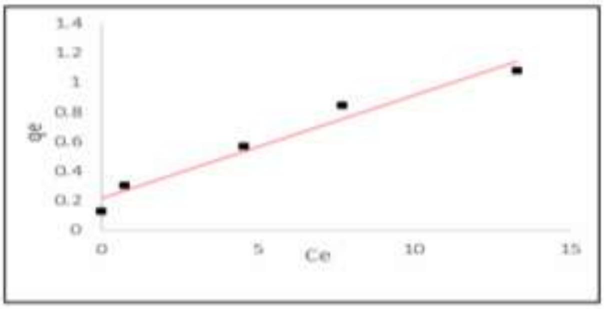


Fig (15): Equilibrium isotherm for Fe^{2+} by rice husk

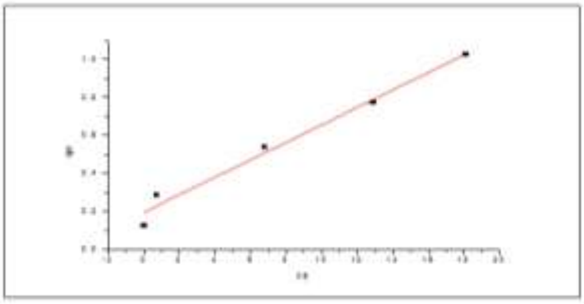
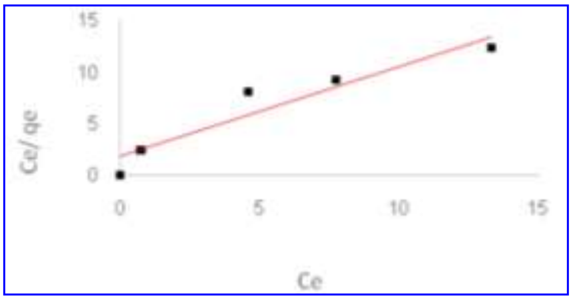


Fig (16): Equilibrium isotherm for Pb^{2+} by rice husk.

Adsorption isotherm study was carried out on three isotherm models; Langmuir, Freundlich and Tempkin models. Applicability of isotherm equation to describe adsorption process was judged by coefficients (R^2) value.

3.3.1. Langmuir Isotherm

Langmuir isotherm of ideal localized monolayer was developed to represent chemisorption. Isotherm data had been linearized using Langmuir equation and plotted between C_e/q_e versus C_e for Fe^{2+} and Pb^{2+} by rice husk, respectively (Fig, 17 and 18). Langmuir constant q_m, which is a measure of monolayer adsorption capacity of rice husk was obtained as 1.77 and 2.23mg g^{-1} for Fe^{2+} and $Pb^{2+}$by rice husk, respectively. Langmuir constant, K_m, which denoted adsorption energy, was 0.88 and 0.99 mg^{-1} for Fe^{2+} and Pb^{2+} by rice husk, respectively. High value of regression correlation coefficient R^2 was 0.88 and 0.865for Fe^{2+} and Pb^{2+} by rice husk, respectively was obtained which indicated good agreement between the experimental values and isotherm parameters.



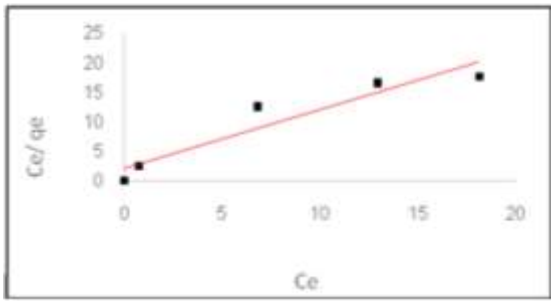


Fig (17): Langmuir isotherm for Fe^{2+} by rice husk.

Fig (18): Langmuir isotherm for Pb^{2+} by rice husk.

3.3.2. Freundlich Isotherm

Applicability of Freundlich isotherm was analyzed based on adsorption on heterogeneous surface using the same equilibrium data of heavy metals by rice husk adsorption. Freundlich constants, K_f and n were obtained by plotting graph between $\ln q_e$ versus $\ln c_e$ are shown in Fig (19 and 20). K_f values were -1.01 and -1.136 for Fe^{2+} and Pb^{2+}, by rice husk respectively, and the value of n was 0.435 and 0.352 for Fe^{2+} and Pb^{2+} by rice husk, respectively. It was found that regression correlation coefficient obtained from Freundlich isotherm model for rice husk was 0.9625 and 0.912 for Fe^{2+} and $Pb^{2+}$by rice husk, respectively. Freundlich isotherm model was widely used but does not provide the information on monolayer adsorption capacity. The obtained result indicated that the equilibrium data was fitted well with Freundlich isotherm model.

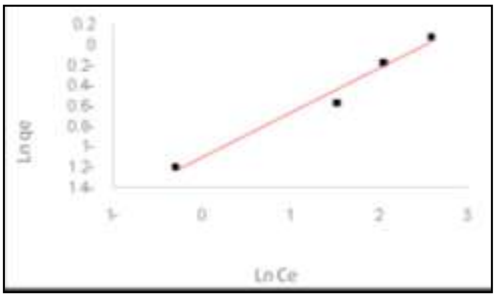


Fig. (19): Freundlich isotherm for Fe^{2+} by rice husk.

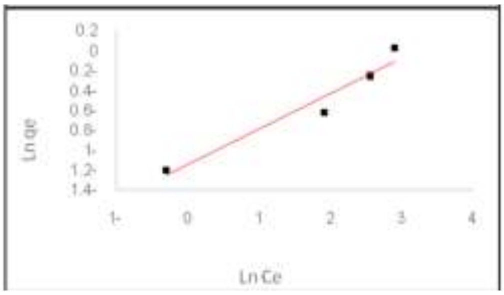


Fig. (20): Freundlich isotherm for Pb^{2+} by rice husk.

3.3.1. Tempkin Isotherm

A plot of q_e versus lnC_e at constant temperature was used to calculate the Tempkin isotherm constants, q_m and K_T is shown in Fig (21 and 22). The constants K_T obtained for Tempkin isotherm mode was -1.007 and 0.312 mg g^{-1} for Fe^{2+} and Pb^{2+} by rice husk, respectively, and q_m was 3.544 and 0.195 for Fe^{2+} and Pb^{2+} by rice husk, respectively. The obtained regression correlation coefficient for Tempkin isotherm model was 0.854 and 0.75 for Fe^{2+} and Pb^{2+} by rice husk, respectively.

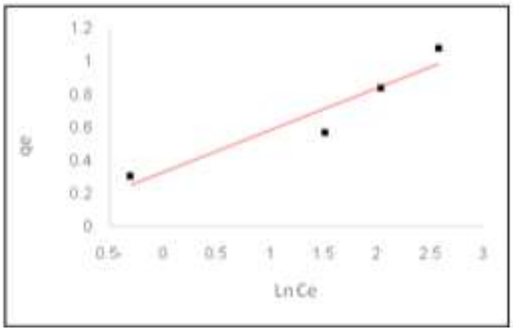


Fig (21): Tempkin isotherm for Fe^{2+} by rice husk.

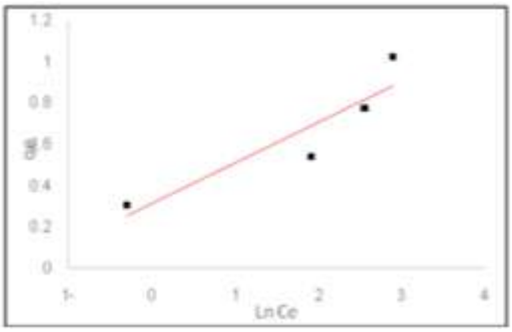


Fig (22): Tempkin isotherm for Pb^{2+} by rice husk.

Finally, Freundlich isotherm model was found to be the best fit most suitable for each of heavy metals at R^2= 0.96 and 0.91 for Fe^{2+} and Pb^{2+} respectively. This means that the adsorption was multilayer and took place on heterogeneous surface.

3.4. Adsorption Kinetics for Rice Husk

Kinetic of adsorption was determined by analyzing adsorption uptake of the heavy metals at different time Intervals. The amount of dry adsorbed on rice husk at time t, q_t (mg/g rice husk) was calculated by following equation:

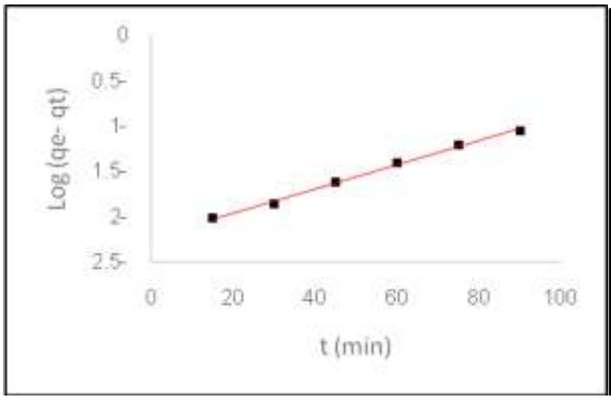
$$q_t = (c_i - c_t) * (V/W) * 10^{-3}$$

Where;
c_t, ci are the concentration of heavy metals at equilibrium and initial (mg/l). q_t is the concentration of heavy metals in solid phase at equilibrium (mg/g). V is the volume of solution (ml). W is the mass of dry adsorbent (g).

Adsorption kinetics provided details on the adsorption mechanism of adsorabte onto an adsorbent. In order to understand kinetics of removal of Fe^{2+} and Pb^{2+} using rice husk, pseudo first-order and second-order kinetic models are tested with experimental data.

3.4.1. Pseudo First-Order Kinetics

Plot of log (q_e-q_t) versus t gave a straight line which represented pseudo first-order kinetics for the removal of Fe^{2+} and Pb^{2+} using rice husk (Figs. 23 and 24). The values of first-order rate constants, k_1 and q_e for initial heavy metals concentration by rice husk were calculated. The regression correlation coefficient was found to be 0.959 and 0.943 for Fe^{2+} and Pb^{2+} by rice husk, respectively.



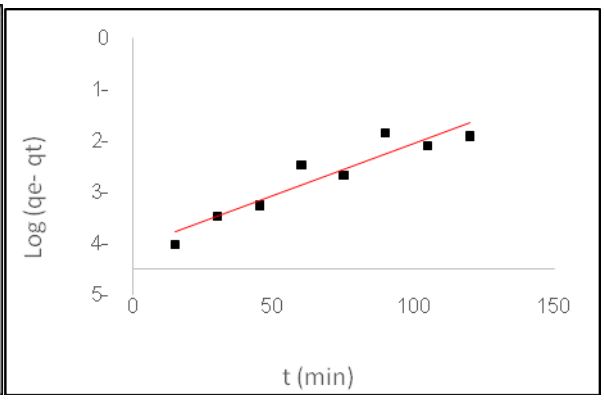


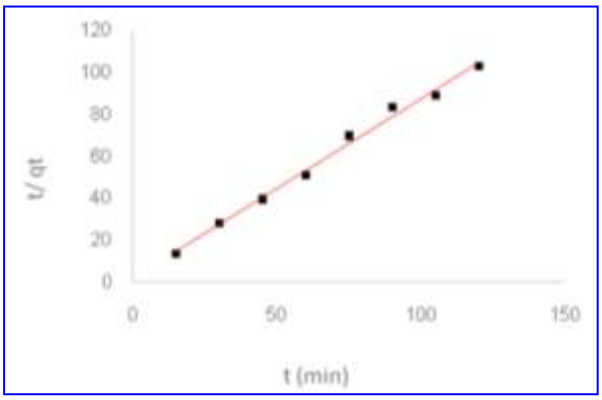
Fig (23): Pseudo first-order kinetics for Fe^{2+} by rice husk.

Fig (24): Pseudo first-order kinetics for Pb^{2+} by rice husk.

3.4.2. Pseudo Second-Order Kinetics

As a result of non-applicability of pseudo first-order, kinetics for adsorption of Fe^{2+} and Pb^{2+} by rice husk was tested with the second-order kinetic model which shown in Fig (25 and 26). Application of second order kinetics by plotting t/qt vs. t, yielded the second-order rate constant, k_2, calculated equilibrium capacity q_e, and regression correlation coefficient for Fe^{2+} and Pb^{2+} by rice husk were calculated. The regression correlation coefficients were found to be 0.99 and 0.976 for Fe^{2+} and $Pb^{2+}$by rice husk, respectively.

Finally, pseudo second order kinetic model had a much better correlation fit for the adsorption of heavy metals than the pseudo first-order model for all initial heavy metal's concentrations. Fe^{2+} and Pb^2 at R^2=0.99 and 0.976, respectively.



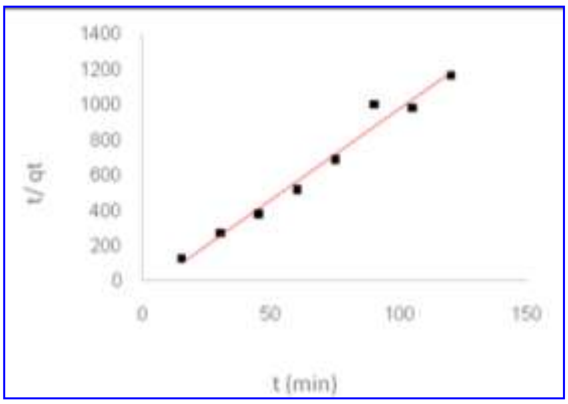


Fig (25): Pseudo second-order kinetics for

Fig (26): Pseudo second-order kinetics for

3.5. Thermodynamic Studies for Rice Husk

Thermodynamic parameters evaluated for Fe^{2+} and Pb^{2+} adsorption onto rice husk are the free energy change (ΔG), enthalpy change (ΔH), and entropy change (ΔS). These parameters were calculated using the following equation:

$$\Delta G = -RT \ln K \quad K = qe/Ce$$

$$\Delta G = \Delta H - T\,\Delta S$$

The values of (ΔH) and (ΔS) were determined from the slope and intercept of the plot of ln K versus 1/T and the Gibbs free energy change of sorption (ΔG) was calculated.

In any adsorption process, free energy, entropy and enthalpy must be taken into account to determine what process will occur spontaneously.The thermodynamic parameters ΔH, ΔS and ΔG of the Fe^{2+} and Pb^{2+} by rice husk sorption from the aqueous solution were calculated employing the above equations. The plot of q_e/c_e versus 1/T was linear over temperature range of 293.15-313.15 K. The value of ΔH, ΔS and ΔG was calculated from the slope and intercept of Fig (27 and 28). The value of ΔH confirmed the exothermic nature for Fe^{2+}, and endothermic for Pb^{2+}. The increase of ΔG with temperature was attributed to the spontaneous nature of the adsorption process which was more favorable at low temperature.

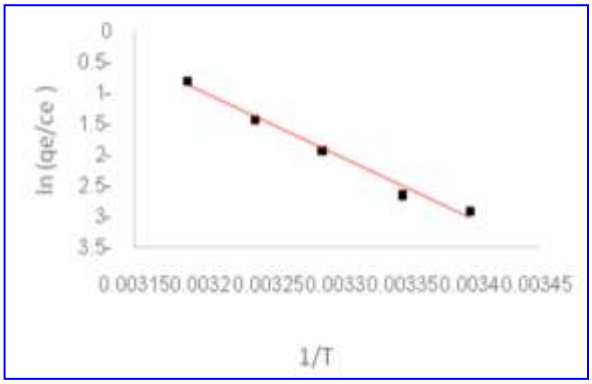


Fig (27): Thermodynamic parameters for Fe^{2+} by rice husk.

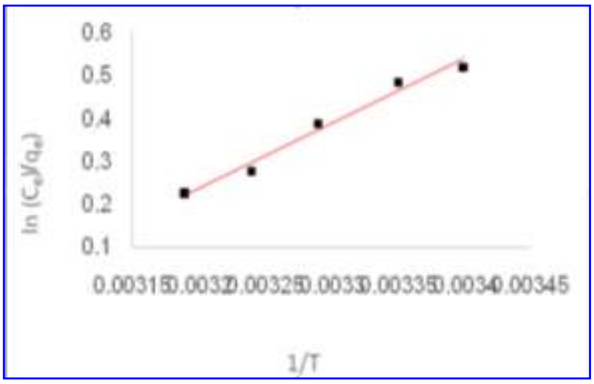


Fig (28): Thermodynamic parameters for Pb^{2+} by rice husk.

3.6. Adsorption Behavior Investigation of Fe^{2+} and Pb^{2+} Ionsof Drains Discharged into Burullus Lake Using Rice Husk:

The adsorption technique using rice husk was used for the treatment of two heavy metals (Fe^{2+} and Pb^{2+}) in two drains (Khashaa drain and Tera drain) which are discharged into Burullus Lake. The results revealed a good removal of the two heavy metals using rice husk under optimum conditions with removal percentage 91.36% and 94.42% for Fe^{2+}, respectively and Pb^{2+} in Khashaa drain and 93.56% and 90.93% for Fe^{2+} and Pb^{2+}, respectively in Tera drain (Table 1 and 2).

The adsorption was in the order ofPb^{2+}> Fe^{2+} in Khashaa drain, whereas in the order of Fe^{2+}> Pb^{2+} in Tera drain. This was most probably due to the strong interaction between metal ions and active functional groups inside rice husk. In order to obtain quantitative recoveries of the metal ions on rice husk, the pre-concentration procedure was optimized for various analytical parameters such as contact time, pH, and the amount of rice husk, temperature and initial heavy metals concentration.

Table (1): Removal Percentage of Fe $^{2+}$ and Pb^{2+} in Khashaa drain using rice husk

Metal Ion	Removal Percentage %
Fe^{2+}	**91.36**
Pb^{2+}	**94.42**

Table (2): Removal Percentage of Fe $^{2+}$ and Pb^{2+} in Tera drain using rice husk

Metal Ion	Removal Percentage %
Fe^{2+}	**93.56**
Pb^{2+}	**90.93**

CONCLUSION

The rice husks are an agricultural waste substance. This product exhibits very good adsorptionfor heavy metals; Fe^{2+} and Pb^{2+} from wastewater. Adsorption of Iron and Lead by rice husks has been shown to depend significantly on the pH, rice husks dosage and contact time.The sorption of Pb and Fe ions has been shown to be dependent upon pH, with best sorption occurring between pH 6 and 8.Freundlich isotherm model was found to be the best fit most suitable for each of heavy metals at R^2= 0.96, 0.91. Kinetic studies showed that pseudo-second-order reaction model best described the adsorption process.

The present study showed that rice husk can be effectively used as adsorbent for treatment of wastewater as it could bring about a removal up to 91.36% and 94.42% for Fe^{2+}, respectively and Pb^{2+} in Khashaa drain and 93.56% and 90.93% for Fe^{2+} and Pb^{2+}, respectively in Tera drain. Moreover it is a cost-effective process since it is cheaply available raw material.

REFERENCES

APHA (American Public Health Association) (1999). Standard Methods for the Examination of Water and Wastewater (20th edn). Washington, DC:USA.

Ashruta, G.A.; Nanoty, V.D. and Bhalekar, U.K. (2014). Biosorption of Heavy Metals from Aqueous Solution using Bacterial EPS. Int. J. Life Sci.,. 2(4):.373-377.

Ayangbenro, A.S., Babalola, O.O. (2017). A New Strategy for Heavy Metal Polluted Environments: A Review of Microbial Biosorbents. Int. J. Environ. Res. and Public Health, 14(94):1-16.

Azimi, A.; Azari, A.; Rezakazemi, M. and Ansarpour, M. (2017). Removal of Heavy Metals from Industrial Wastewaters: A Review. Chem. Bio. Eng. Rev., 4(1):1–24.

Banerjee, S., and Chattopadhyaya, M. C. (2013). Adsorption Characteristics for the Removal of AToxic Dye, Tartrazine from Aqueous Solutions by ALow-Cost Agricultural By-Product. Arabian J. Chem., 10(2):S1629–S1638.

Bernard, E., Jimoh, A. and Odigure, J.O. (2013). Heavy Metals Removal from Industrial Wastewater by Activated Carbon Prepared from Coconut Shell. Res. J. Chem. Sci., 3(8):.3-9.

Gervas,C.; Mubofu, E.B.; Mdoe, J.E.G. and Revaprasadu,N. (2015). Functionalized mesoporous organo-silica nanosorbents for removal of chromium (III) ions from tanneries wastewater. J. Porous Mater., 23: 83–93.

Coelho, T.C.; Favere, V.T.; Laus, R.; Laranjeira, C.M. and, Mangrich, A.S. (2007). React. Funct. Polym., 67:468–475.

Das,N.; Vimala,R. and Karthika, P.(2008). Biosorption of heavy metals J. Appl. Sci. Agricult., . 9(11): 159–169.

Swathi, M.; Sathya, S.A.; Aravind, S.; Ashi, S.P.K.; Gobinath, R. and Saranya, D.D. (2014). Adsorption studies on tannery wastewater using rice husk. Scholars J. Engineering Technol. (SJET), 2(2B): 253-257.

Dixit, R., Malaviya, D., Pandiyan, K., Singh, U.B., Sahu, A., Shukla, R., Singh, B.P., Rai, J.P., Sharma, P.K., Lade, H., Paul, D. (2015). Bioremediation of Heavy Metals from Soil and Aquatic Environment: An Overview of Principles and Criteria of Fundamental Processes. Sustainability**,** 7:2189-2212.

El-Amier, Y.A., El-Azim, H.A., El-Alfy, M.A. (2016). Spatial Assessment of Water and Sediment Quality in Burullus Lake Using GIS Technique. J. Geography, Environ. Earth Sci. Int., 6(1):.1-16.

Gunatilake, S.K. (2015). Methods of Removing Heavy Metals from Industrial Wastewater. J. Multidisciplinary Engineering Sci. Studies (JMESS), 1 (1):12-18.

Hussein, H.; Ibrahim, S.F.; Kandeel, K. and Moawad, H. (2004). Biosorption of heavy metals from waste water using *Pseudomonas* sp. Electronic J. Biotechnol.,7 (1):.38-46.

Ince, M. and Ince, O.K. (2017). An Overview of Adsorption Technique for Heavy Metal Removal from Water/Wastewater:A Critical Review.Int.J.Pure Appl. Sci., .3(2): 10–19.

Mahurpawar, M. (2015). Effects of heavy metals on human health. Int. J. Res. pp.1-7.

Mehmet E.A., Sukru D., Celalettin O. and Mustafa K. (2006). Heavy metal adsorption by modified oak sawdust, J. of Hazard. Mater, InPress.

Morais, S., Garcia, F., Pereira, M.D.L. (2012). Heavy Metals and Human Health. In: Oosthuizen J (ed) Environmental health—emerging issues and practice, Vol. 10. In Tech Open, pp227–246.

Nagajyoti, P.C., Lee, K.D., Sreekanth, T. V. M. (2010). Heavy metals, occurrence and toxicity for plants: a review. *Environ Chem Lett*, Vol. 8, pp.199–216.

Sudha, R. and Premkumar, P. (2016). Lead Removal by Waste Organic Plant Source Materials Review. Int. J. Chem. Tech. Res., 9 (1):47-57.

Zhang, H. (2014). Biosorption of heavy metals from aqueous solutions using keratin biomaterials. PhD inchemistry.

إزالة أيونات الحديد والرصاص من مياه الصرف باستخدام قشر الأرز

أحمد عبد الحليم[1] ، خالد حسن العزبي} ، مي إبراهيم الجمال{ ، هبه محمد صابر[1]
1-البيئة البحرية- المعهد القومي لعلوم البحار والمصايد- مصر
2- قسم علوم البيئة- كلية العلوم- جامعة دمياط- مصر

إن هناك حاجة ملحة إلى استكشاف جميع المصادر الممكنة من المواد الممتزة غير المكلفة وإمكانية استخدامها لإزالة المعادن الثقيلة. وهكذا تقدم هذه الدراسة تطبيق المخلفات الزراعية منخفضة التكلفة مثل قشر الأرز للتخلص من أيونات الحديد والرصاص في مياه الصرف عن طريق عملية الامتزاز.
تم استخدام تقنية الامتزاز لإزالة أيونات الحديد والرصاص في اثنين من المصارف (مصرف الخاشعة ومصرف تيرة) والتي تصرف مياهها في بحيرة البرلس.
أظهرت النتائج التي تم الحصول عليها أن عملية امتزاز أيونات المعادن تعتمد على الأس الهيدروجيني و كمية المادة المستخدمة في عملية الامتزاز وتركيز المعدن.
كما كشفت النتائج عن إزالة جيدة لأيونات الحديد والرصاص باستخدام قشر الأرز في ظل الظروف المثلى مع نسبة إزالة 91.36% للحديد و 94.42% للرصاص في مصرف الخاشعة و 93.56% للحديد و 90.93% للرصاص في مصرف تيرة. لذلك أظهرت الدراسة أن قشر الأرز يمكن استخدامه بكفاءة كبديل منخفض التكلفة لإزالة أيونات المعادن.