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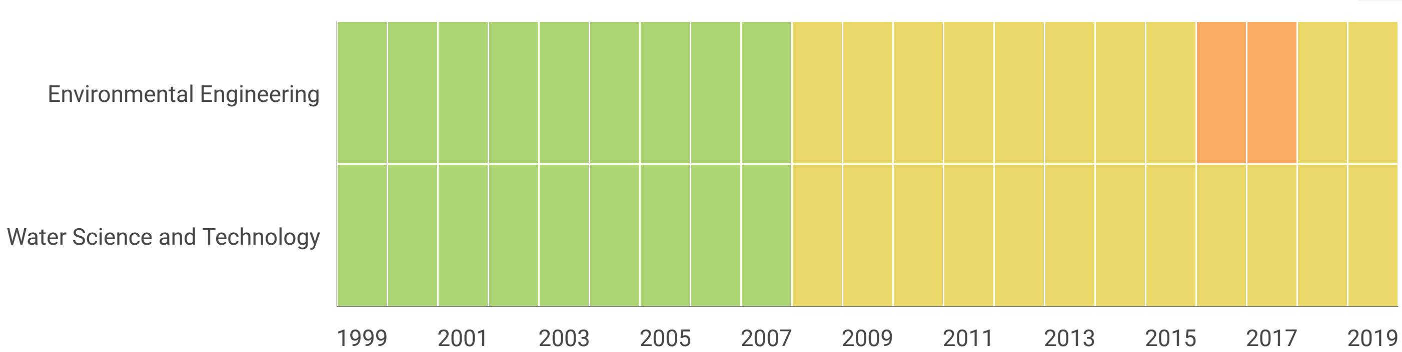

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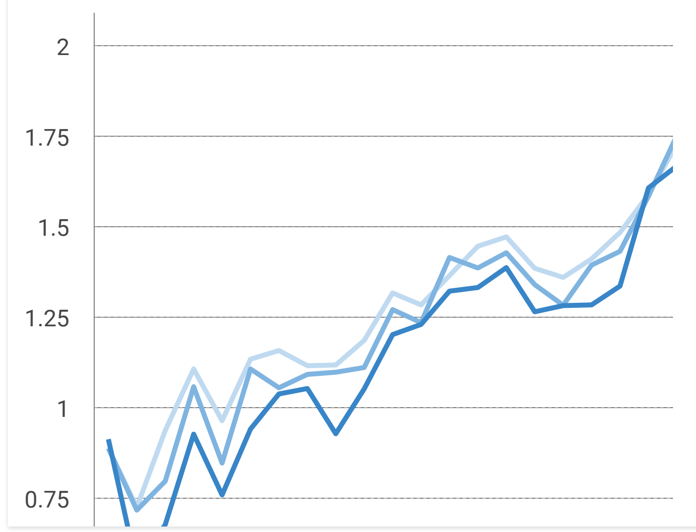

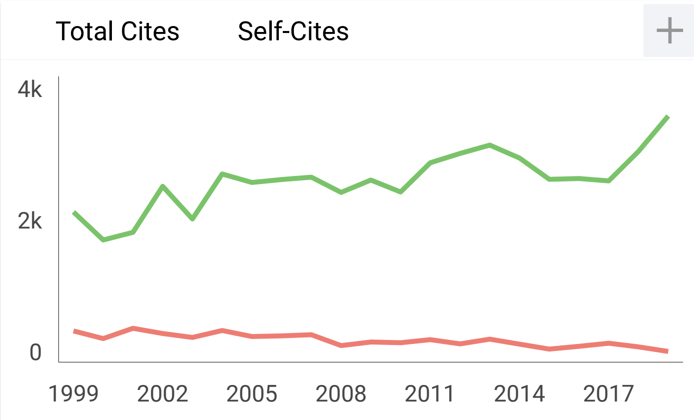

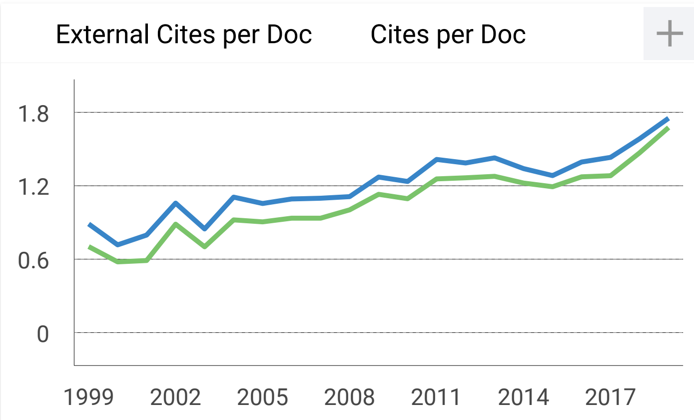

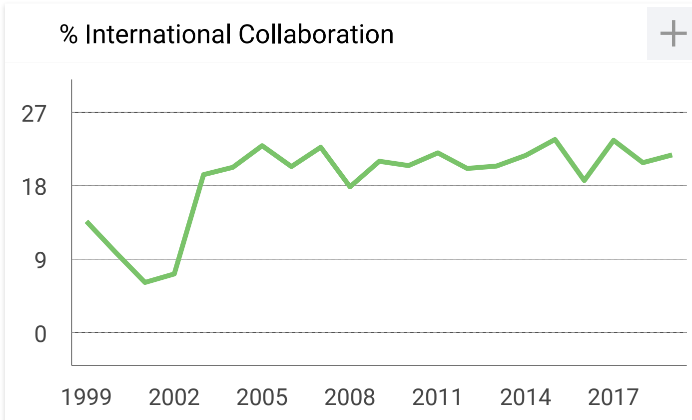

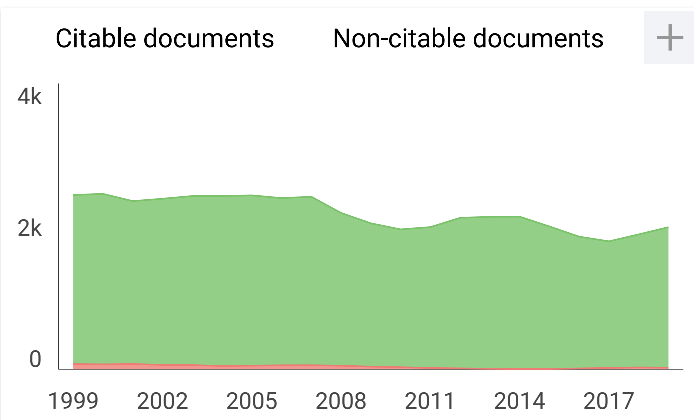

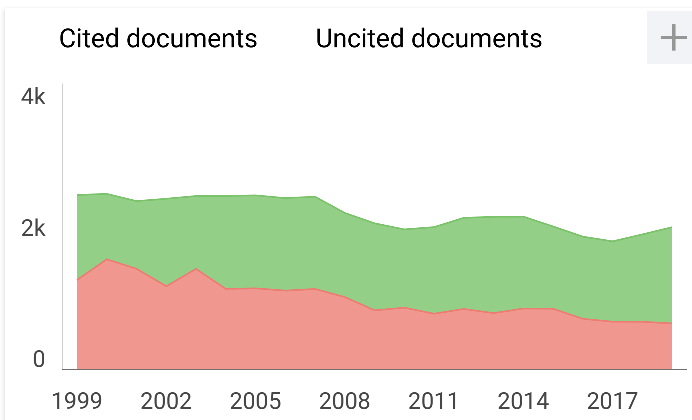

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Utilization of maize husk (*Zea mays* L.) as low-cost adsorbent in removal of iron from aqueous solution

S. Indah, D. Helard and A. Sasmita

ABSTRACT

Adsorption of iron from aqueous solution by using maize husk (*Zea mays* L.) as a low-cost adsorbent was studied. Batch experiments were carried out at ambient temperature, 0.075–0.250 mm of particle size and 100 rpm of agitation speed to determine the influence of initial pH, adsorbent dose, initial concentration and contact time on the removal of iron. Langmuir and Freundlich models were applied to describe the adsorption isotherm of iron by maize husk. The results showed that optimum condition of iron removal were 4 of pH solution, 20 g/L of adsorbent dose, 10 mg/L of Fe concentration and 15 min of contact time of adsorption with 0.499 mg Fe/g maize husk of adsorption capacity. Experimental data fitted well to Langmuir's adsorption equilibrium isotherm within the concentration range studied. This study demonstrated that maize husk, which is an agricultural waste, has potential for iron removal from groundwater or other polluted waters.

Key words | adsorption, groundwater, iron, maize husk

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INTRODUCTION

Nowadays, the removal of heavy metal contaminants from aqueous wastewater is one of the most important environmental issues being investigated. Some heavy metals usually form compounds that can be toxic, carcinogenic or mutagenic, even in very low concentrations. Apart from the fact that their existence in aquatic ecosystems may cause harmful effects to organisms living in water, heavy metals are also accumulated throughout the food chain and may affect the health of human beings (Zhang *et al.* 2014).

Iron is found in rocks and soil. Under proper conditions, iron will leach into the water resources from rock and soil formations; therefore, iron is common in groundwater supplies used by many small water systems. Exceeding the suggested maximum contaminant levels usually results in water staining that adversely affect plumbing fixtures, dishware and clothes and produce a yellow to reddish appearance in water. These levels may also deliver taste and odour of drinking water. This, in turn, results in consumer complaints and a general dissatisfaction with the water utility. The problems caused by iron are not only aesthetic problems, but also indirect health concerns (Ahayla *et al.* 2006). There are many problems that result from iron toxicity including anorexia, oliguria, diarrhea, hypothermia, diphasic shock, metabolic acidosis and even death. The US Environmental Protection Agency has established a secondary drinking water regulation of 0.3 mg/L for iron (Machmeier 1990). Therefore, it becomes necessary to remove this heavy metal from water by an appropriate treatment technology before releasing it into the environment (Moreno-Piraján *et al.* 2011).

Conventional methods for heavy metal removal include chemical precipitation, ion exchange, electrodialysis, adsorption process, membrane separations, reverse osmosis, and solvent extraction. Most of these methods suffer from some disadvantages such as high operational cost and are not suitable for small-scale industries or do not lead to a satisfactory result. Among these methods, adsorption is a most common technique for the metal removal because adsorption is low cost, has a simple design, is easy to perform and is insensitive to toxic substances (Bingöl *et al.* 2012). Adsorption onto activated carbon has been widely applied for removing metals from water and wastewater. However, adsorbent-grade activated carbon is expensive, and the regeneration of activated carbon for reuse increases the cost (Gong *et al.* 2009; Anirudhan & Sreekumari 2011). Therefore, more interests have recently arisen in the investigation of low-cost adsorbents with a good sorption capacity to remove heavy metal ions from water and wastewater. For the past few decades, several researchers have reported on

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the potential use of agricultural byproducts as good adsorbents for the removal of metal ions from aqueous solutions and wastewaters, such as pine bark wastes (Acemioglu 2004), coir fibres (Shukla *et al.* 2006) and rice husk ash (Zhang *et al.* 2014). This process attempts to put into use the principle of using waste to treat waste and becomes even more efficient because these agricultural byproducts are readily available and often pose waste disposal problems (Abidin *et al.* 2011). The use of waste material as an adsorbent would minimize the total amount of waste, which is a step towards a more 'earth-friendly' process (Jalil *et al.* 2012).

The aim of this research is to develop inexpensive, highly available, effective metal ion adsorbents from agricultural wastes as an alternative to existing commercial adsorbents. The ability of maize husk, a byproduct of agricultural activities that is available in a great abundance in Padang, West Sumatera, Indonesia, for removal of iron in aqueous solution was investigated. Maize husk is known as a lignocellulosic-rich material with the major constituents being 38.2% cellulose, 44.5% hemicellulose, 6.6% lignin, 1.9% protein, 2.8% ash, and the rest being undetermined materials (Barl *et al.* 1991). Batch experiment and isotherm studies were carried out in a laboratory scale to evaluate the adsorption capacity of maize husk. The parameters affecting the adsorption process such as pH, dose of adsorbent, initial concentration and contact time on iron removal were studied.

MATERIALS AND METHODS

Preparation of adsorbent

The maize husk used as the adsorbent was obtained from the waste of agricultural activities in Padang, West Sumatera, Indonesia. It was washed with distilled water, dried, ground, sieved (range from 0.075 to 0.250 mm) and used as adsorbent in present study.

Preparation of iron solution

Iron solutions with known concentrations were prepared by dissolving Fe $(NH_4)_2(SO_4)_2.6H_2O$ in deionized water.

Biosorption experiments

Batch biosorption experiment was carried out at room temperature (20–25 °C) by varying pH of solution, adsorbent dose and contact time. In each experiment, 100 mL of iron solutions of known initial concentration was treated with a specified known concentration of maize husk (20–60 g/L) and known pH (3–5) for a specified period of time (15–60 min) in a set of Erlenmeyer flasks. The Erlenmeyers were shaken with a shaker machine at a speed of 100 rpm. After a period of time, the adsorbent was separated from the metal solution by using Whatman's filter paper no. 42 and the concentration of iron in the filtrate was determined by atomic absorption spectrometry (Rayleigh WFX 320, China). The amount of metal ion adsorbed by the maize husk was gotten as the difference between the initial and final ion concentrations of the solutions. All experiments were repeated three times and results presented are, consequently, the averaged values of replicate tests.

At any time, t, the adsorption capacity of iron adsorbed (*qt*, mg/g) or the Fe uptake on maize husk was calculated by the following mass-balance equation:

$$qt = \frac{C_0 - C_t}{W} \times V \tag{1}$$

where C_0 is the initial concentration of iron (mg/L), C_t is the equilibrium concentration of iron (mg/L), V is the volume of the solution (L), and W is the mass of the adsorbent (g).

RESULTS AND DISCUSSION

Effect of pH

The initial solution pH plays an important role in the adsorption process by affecting the surface charge of adsorbent, the solubility of metal and the competition of metallic ions. Differences in initial pH directly affect the competitive ability of hydrogen ions with metal ions for the active sites on the adsorbent surface (Ahayla *et al.* 2003). The effect of pH on the adsorption of iron onto maize husk was studied at pH 3–5 and the results are presented in Figure 1. For this, the initial concentration of iron was chosen at 10 mg/L and the maize husk dosage was taken as 60 g/L. It was observed that in the period of time from 15 to 60 min, as pH increased from 3 to 4, the Fe uptake also increased from 0.127–0.139 mg/g to 0.137–0.148 mg/g. However, at pH 5, the Fe uptake decreased to 0.122–0.124 mg/g. Thus, the optimum pH for adsorption of iron onto maize husk was observed at pH 4. Similar findings on pH trend has been reported in iron studies by other researchers (Abdulrasaq & Basiru 2010; Lugo-Lugo *et al.* 2012). At low pH, the binding sites of adsorbent are being protonated

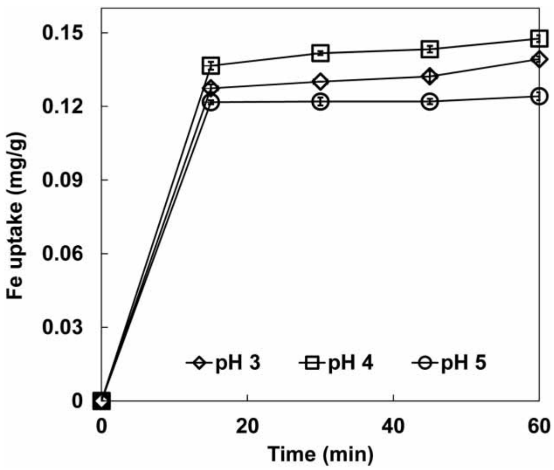

Figure 1 | Effect of pH on adsorption capacity of iron onto maize husk at time variation (iron concentration: 10 mg/L; adsorbent dose: 60 g/L).

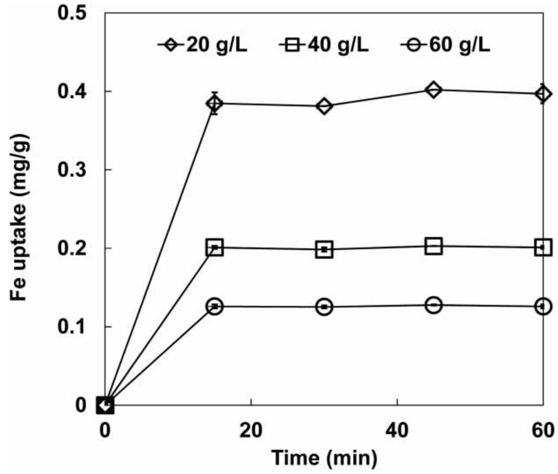

Figure 2 | Effect of adsorbent dose on adsorption capacity of iron onto maize husk at time variation (iron concentration: 10 mg/L; pH: 4).

and charge repulsion occurred between the binding sites and the cations. In addition, the cations compete with the H^+ ions in the solution for the binding sites and, thus, reduce the adsorption process. Conversely, at high pH, the binding sites of adsorbent are deprotonated and causes negative charges on the binding sites to appear and, thus, attract the cations (Amarasinghe & Williams 2007). At very high pH values, the metal hydroxide complexes forms and results precipitation and, therefore, the separation may not be due to adsorption. All the following experiments were carried out with pH values of 4.

Effect of adsorbent dose

The study on the effect of adsorbent dose is necessary and very useful in order to find out the optimum amount of maize husk required for the removal of iron. Figure 2 shows the effect of the maize husk dose (20–60 g/L) on the adsorption of iron from aqueous solution. The initial concentration of iron was fixed as 10 mg/L. It was revealed that the Fe uptake decreased as the adsorbent dose increased. The uptake capacity of Fe decreases from 0.381–0.402 mg/g to 0.125–0.128 mg/g by increasing the adsorbent dose from 20 to 60 g/L in the period of time from 15 to 60 min. The highest Fe uptake was obtained at the lowest dose of maize husk studied (20 g/L). This may be due to the agglomeration of adsorbent particles at high adsorbent dose, reducing the available external surface area, as well as to the strong limitations of Fe species mobility in the adsorption medium, leaving some binding sites unsaturated (Amarasinghe & Williams 2007; Aryal *et al.* 2010; Nieto *et al.* 2010). Since the highest sorption was found on 20 g/L of adsorbent dose on the removal of iron, all the following experiments were carried out with 20 g/L of adsorbent dose.

Effect of initial concentration

The effect of initial concentration of iron in the range of 1–10 mg/L on adsorption was also investigated. Figure 3 shows the variation of iron adsorption over time for three experiments with different initial iron concentrations. The results showed that as the initial iron concentration increased, the adsorption capacity or Fe uptake increased and it remained nearly constant until the end of contact time. The Fe uptakes were found in the range of

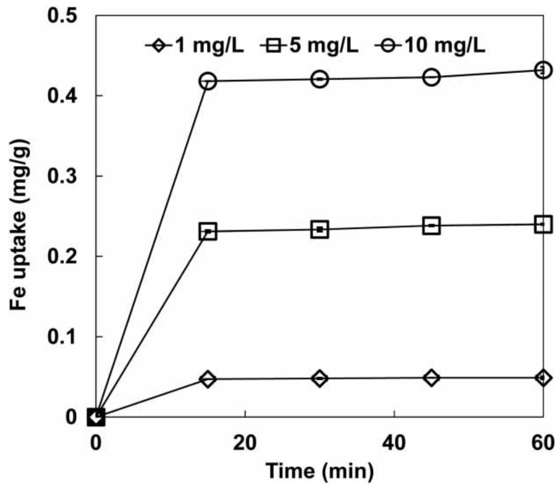

Figure 3 | Effect of initial concentration on adsorption capacity of iron onto maize husk at time variation (pH: 4; adsorbent dose: 20 g/L).

0.047–0.049 mg/g, 0.231–0.240 mg/g and 0.418–0.432 mg/g at initial concentration of 1 mg/L, 5 mg/L and 10 mg/L, respectively, in period of time from 15 to 60 min. The results indicated that a higher initial concentration of iron can enhance the adsorption process. The initial iron concentration provides the necessary driving force to overcome the resistances to the mass transfer of iron between the aqueous phase and the solid phase. The increase in initial iron concentration also enhances the interaction between iron and maize husk as adsorbent, resulting in the higher adsorption capacity of iron. This is due to an increase in the driving force of concentration gradient, as an increase in the initial iron concentration. The same conclusion was obtained by Ahluwalia & Goyal (2005), Nieto *et al.* (2010) and Kamarudzaman *et al.* (2013) for the sorption of iron onto tea leaves biomass, crude olive stones and *Pleurotus ostreatus* spent mushroom compost, respectively.

Effect of contact time

The contact time is one of the important factors that influence the adsorption process of metals in a medium. Selection of proper adsorption time of heavy metals in wastewater treatment has certain economic benefits (Zhang *et al.* 2014). The effect of contact time on iron adsorption onto maize husk is shown in Figures 1–3. For all of the experiments, the adsorption of iron is most rapid in the initial stages and the equilibrium was achieved within 15 min (Figures 1–3). After that, the uptake capacity of Fe increases slowly until 45 min and a further increase in contact time has a negligible effect on adsorption capacity. This result may be due to the availability of vacant adsorption sites on the adsorbent surface during the initial stage of sorption. After a lapse in time, the remaining vacant surface sites were occupied due to repulsive forces between the solute molecules on the adsorbent surface and the bulk phase, resulting in the relative inaccessibility of the remaining binding sites (Aryal *et al.* 2010). However, the contact time of 1 h could be considered for adsorption of iron onto maize husk for entire batch studies.

Adsorption isotherm models

Adsorption isotherms describe the adsorption process and how adsorbates interact with a biosorbent. It is important to establish the most acceptable correlations for the batch equilibrium data for analysis and design of adsorption systems. The most frequently used models to describe the equilibrium data of adsorption are Langmuir and Freundlich isotherm models. Those models were applied in the present work to study the adsorption isotherms of iron onto maize husk. The Langmuir model assumes that the uptake of metal ions is monolayer sorption on a homogenous surface and without any interaction between adsorbed ions (Langmuir 1918). This model is represented by the following equation:

$$\frac{C_e}{q_e} = \frac{C_e}{q_{max}} + \frac{1}{K_L q_{max}} \tag{2}$$

where C_e is the equilibrium concentration of iron in solutions (mg/L), q_e is the equilibrium concentration of iron on the adsorbent (mg/g), q_{max} is the maximum adsorption capacity of the adsorbent (mg/g), and K_L is the Langmuir adsorption constant (L/mg).

The favourability of the adsorption could also be demonstrated by the value of essential characteristics of the Langmuir isotherm (R_L), which is a dimensionless constant that is the separation factor. The R_L can yield an isotherm shape that is unfavourable ($R_L > 1$), linear ($R_L = 1$), favourable ($0 < R_L < 1$) or irreversible ($R_L = 0$). Using the following equation:

$$R_L = \frac{1}{1 + K_L C_0} \tag{3}$$

The Freundlich model assumes a heterogeneous adsorption surface and active sites with different energy (Freundlich 1906). Freundlich model is represented by the following equation:

$$q_e = K_F C_e^{1/n} \tag{4}$$

The linearized logarithmic form of the equation is:

$$\log\, q_e = \log\, K_F + \frac{1}{n} log\, C_e \tag{5}$$

where K_F is the Freundlich constant of the relative adsorption capacity of the adsorbent and the empirical parameter $1/n$ indicates the adsorption intensity. Smaller value of $1/n$ implies stronger interaction between the adsorbent and heavy metal, while $1/n$ values exist between 0 and 1, indicating the identical adsorption process and adsorption energies for all sites.

In order to determine the adsorption isotherm of iron adsorption onto maize husk, the initial iron concentration was varied in the interval ranging from 1 to 10 mg/L with 4 of pH and 20 g/L of adsorbent dose. Figure 4(a) shows the linearized form of the Freundlich isotherm model which was obtained by plotting log q_e against log C_e values. From this plot, the values of the R^2 was found to be 0.951 for iron adsorption. Moreover, the Langmuir isotherm was obtained by plotting C_e/q_e against C_e values, and the correlation coefficient (R^2) was 1 (Figure 4(b)). These results indicate that the Freundlich model was not adequate to describe the relationship between the amount of adsorbed iron and its equilibrium concentration in the solution. Therefore, the result showed that the Langmuir isotherm model fitted well with the equilibrium data as it presents higher R^2 value. These results revealed that on the adsorption of iron onto maize husk, the surface of maize husk as adsorbent is homogeneous and all active sites are energetically symmetrical resulting in monolayer adsorption. It means that the adsorption can only occur at a finite (fixed) number of definite localized sites, that are identical and equivalent, with no lateral interaction and steric hindrance between the adsorbed molecules, even on adjacent sites (Vijayaraghavan et al. 2006). In addition, ion exchange was predicted as the predominant mechanism of the adsorption of iron onto maize husk, since the maize husk is a lignocellulosic-rich material. Ion exchange has been reported as the predominant mechanism involved in many adsorption processes by lignocellulosic wastes (Ngah & Hanafiah 2008).

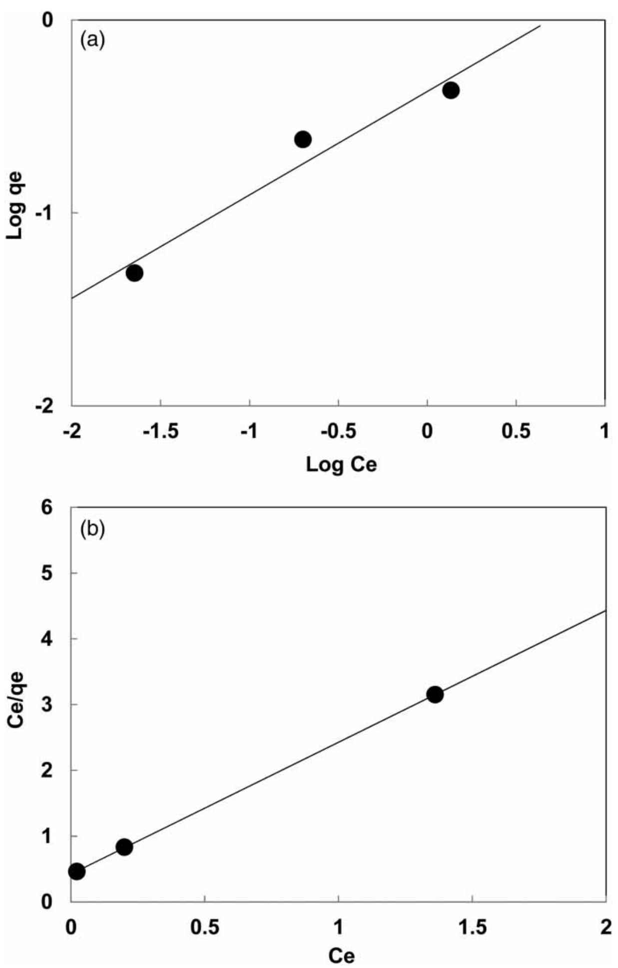

Figure 4 | Freundlich (a) and Langmuir (b) isotherm plots for the adsorption of iron onto maize husk (iron concentration: 1–10 g/L; adsorbent dose: 20 g/L; contact time: 60 min; pH: 4).

The parameters of iron adsorption isotherms for maize husk are shown in Table 1. For favourable adsorption the value of R_L should range in between 0 and 1. The R_L values for the adsorption process were estimated at initial concentration from 1 to 10 mg/L of iron. The R_L were found to be 0.175–0.021 for the initial iron concentration of 1–10 mg/L, indicating that the adsorption of iron by maize husk was favourable.

Comparison study

A comparison of the maximum capacities of different adsorbents, including this study, for the removal of iron from aqueous solutions is presented in Table 2. It is evident that maximum adsorptive capacities for iron were different for different materials used. This will depend on the physical nature and chemical composition of the materials used. The comparison showed that the adsorption capacity of maize husk for iron removal was relatively low compared to other adsorbents reported in the literature. However, as the adsorption of iron by maize husk was favourable, some modifications or pre-treatment steps can be taken to improve the adsorption capacity of maize husk. Further investigation is needed to develop effective metal ion adsorbent from agricultural waste as an alternative to existing commercial adsorbents.

Table 1 | Parameters of the Freundlich and Langmuir models for adsorption of iron onto maize husk at pH 4, 20 g/L of adsorbent dose and 60 min of contact time

Freundlich isotherm model			Langmuir isotherm model			
K_F (L/g)	1/n	R^2	K_L (L/g)	q_{max} (mg/g)	R_L	R^2
0.427	0.536	0.951	4.725	0.499	0.021–0.175	1

Table 2 | Comparison of maximum adsorption capacities of different adsorbents for iron

No.	Adsorbents	Adsorption capacity q_{max} (mg/g)	Contact time (min)	Concentration range (mg/l)	pH	Temperature range (K)	Reference
1	Coir fibres	2.84	120	73.5–83.9	5	308	Shukla *et al.* (2006)
2	Modified coir fibres	7.49	120	73.5–83.9	5	308	Shukla *et al.* (2006)
3	Activated carbon from coconut shells	81.89	90	20–100	6	298	Moreno-Pirajan (2011)
4	Chitosan/polyethylene glycol blend membrane	90.9	80	2–10	5	300	Reiad *et al.* (2012)
5	Pine bark wastes	2.03	30	55.6–111.2	4	303–333	Acemioglu (2004)
6	Rice husk ash	6.21	60	2–40	5	298	Zhang *et al.* (2014)
7	Maize husk	0.499	60	1–10	4	298	Present study

CONCLUSIONS

In this study, the potential of using an agricultural waste, maize husk, has been assessed for the adsorption of iron. In batch mode studies, adsorption was dependent on pH, adsorbent dose, initial iron concentration and contact time. The maximum adsorption capacity (q_{max}) of maize husk was found to be 0.499 mg/g for iron at 10 mg/L of the initial concentration, 4 of pH, 20 g/L of adsorbent dose and 60 min of contact time. The equilibrium adsorption experiments fitted better with Langmuir than Freundlich isotherm models and showed a correlation coefficient R^2 equals 1 and 0.951, respectively. The R_L were found to be 0.175 to 0.021 for the initial iron concentration of 1–10 mg/L, indicating that the adsorption of iron by maize husk was favourable. It can be concluded that the maize husk, an agricultural waste, is a potential alternative material for the removal of iron from groundwater or other polluted waters.

ACKNOWLEDGEMENTS

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REFERENCES

Abdulrasaq, O. O. & Basiru, O. G. 2010 Removal of copper (II), iron (III) and lead (II) ions from mono-component simulated waste effluent by adsorption on coconut husk. *African Journal of Environmental Science and Technology* **4** (6), 382–387.

Abidin, M. A. Z., Jalil, A. A., Triwahyono, S., Adam, S. H. & Kamarudin, N. H. N. 2011 Recovery of gold (III) from an aqueous solution onto a *Durio zibethinus* husk. *Biochemical Engineering Journal* **54**, 124–131.

Acemioglu, B. 2004 Removal of Fe(II) ions from aqueous solution by Calabrian pine bark wastes. *Bioresource Technology* **93** (1), 99–102.

Ahayla, N., Ramachandra, T. V. & Kanamadi, R. D. 2003 Biosorption of heavy metals. *Research Journal of Chemistry and Environment* **7** (4), 71–79.

Ahayla, N., Kanamadi, R. D. & Ramchandra, T. V. 2006 Biosorption of iron(III) from aqueous solutions using the husk of *Cicer arientinum*. *Indian Journal of Chemical Technology* **13**, 122–127.

Ahluwalia, S. & Goyal, D. 2005 Removal of heavy metals by waste tea leaves from aqueous solution. *Engineering Life Science* **5**, 158–162.

Amarasinghe, B. M. W. P. K. & Williams, R. A. 2007 Tea waste as a low cost adsorbent for the removal of Cu and Pb from wastewater. *Chemical Engineering Journal* **132**, 299–309.

Anirudhan, T. S. & Sreekumari, S. S. 2011 Adsorptive removal of heavy metal ions from industrial effluents using activated carbon derived from waste coconut buttons. *Journal of Environmental Science* **23** (12), 1989–1998.

Aryal, M., Ziagova, M. & Liakopoulou-Kyriakides, M. 2010 Study on arsenic biosorption using Fe(III)-treated biomass of *Staphylococcus xylosus*. *Chemical Engineering Journal* **162**, 178–185.

Barl, B., Biliaderis, C. G., Murray, E. D. & Macgregor, A. W. 1991 Combined chemical and enzymic treatments of corn husk lignocellulosics. *Journal of the Science of Food and Agriculture* **56** (2), 195–214.

Bingöl, D., Hercan, M., Elevli, S. & Kılıç, E. 2012 Comparison of the results of response surface methodology and artificial neural network for the biosorption of lead using black cumin. *Bioresource Technology* **112**, 111–115.

Freundlich, H. 1906 Uber die adsorption in Losungen. *Zeitschrift für Physikalische Chemie* **57**, 385–470.

Gong, R., Feng, M., Zhao, J., Cai, W. & Liu, L. 2009 Functionalization of sawdust with monosodium glutamate for enhancing its malachite green removal capacity. *Bioresource Technology* **100**, 975–978.

Jalil, A. A., Triwahyono, S., Yaakob, M. R., Azmi, Z. Z. A., Sapawe, N., Kamarudin, N. H. N., Setiabudi, H. D., Jaafar, N. F., Sidik, S. M., Adam, S. H. & Hameed, B. H. 2012 Utilization of bivalve shell-treated *Zea mays* L. (maize) husk leaf as a low-cost biosorbent for enhanced adsorption of malachite green. *Bioresource Technology* **120**, 218–224.

Kamarudzaman, A. N., Chay, T. C., Jalil, M. F. A., Talib, S. A. & Suhaimi, A. T. 2013 Biosorption of iron (III) from aqueous solution using *Pleurotus ostreatus* spent mushroom compost as biosorbent. *Advanced Materials Research* **781–784**, 636–642.

Langmuir, I. 1918 The adsorption of gases on plane surfaces of glass, mica and platinum. *The Journal of the American Chemical Society* **40** (9), 1361–1403.

Lugo-Lugo, V., Barrera-Díaz, C., Ureña-Núñez, F., Bilyeu, B. & Linares-Hernández, I. 2012 Biosorption of Cr (II) and Fe (III) in single and binary systems onto pretreated orange peel. *Journal of Environmental Management* **112**, 120–127.

Machmeier, R. E. R. 1990 Iron and Drinking Water, AG-FO. 1318, Agriculture, University of Minnesota.

Moreno-Piraján, J. C., Garcia-Cuello, V. S. & Giraldo, L. 2011 The removal and kinetic study of Mn, Fe, Ni and Cu ions from wastewater onto activated carbon from coconut shells. *Adsorption* **17** (3), 505–514.

Ngah, W. S. W. & Hanafiah, M. A. K. M. 2008 Biosorption of copper ions from dilute aqueous solutions on base treated rubber (*Hevea brasiliensis*) leaves powder: kinetics, isotherm, and biosorption mechanisms. *Journal of Environmental Sciences* **20**, 1168–1176.

Nieto, L. M., Alami, S. B. D., Hodaifa, G., Faur, C., Rodríguez, S., Giménez, J. A. & Ochando, J. 2010 Adsorption of iron on crude olive stones. *Industrial Crops and Products* **32**, 467–471.

Reiad, N. A., Salam, O. E. A., Abadir, E. F. & Harraz, F. A. 2012 Adsorptive removal of iron and manganese ions from aqueous solutions with microporous chitosan/polyethylene glycol blend membrane. *Journal of Environmental Sciences* **24** (8), 1425–1432.

Shukla, S. R., Pai, R. S. & Shendarkar, A. D. 2006 Adsorption of Ni(II), Zn(II) and Fe(II) on modified coir fibres. *Separation and Purification Technology* **47** (3), 141–147.

Vijayaraghavan, K., Padmesh, T. V. N., Palanivelu, K. & Velan, M. 2006 Biosorption of nickel(II) ions onto *Sargassum wightii*: application of two-parameter and three parameter isotherm models. *Journal of Hazardous Materials* **B133**, 304–308.

Zhang, Y., Zhao, J., Jiang, Z., Shan, D. & Lu, Y. 2014 Biosorption of Fe(II) and Mn(II) ions from aqueous solution by rice husk ash. *BioMed Research International* **2014** (Article ID 973095), 1–10.

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