Modified banana peels for Fe (II) ion sorption

M L Yuen1,2, A R Ros1, N Nurlyahfizeh1, Y P Tan2 and C W Yuen3

1 Industrial Chemistry Department, Faculty of Industrial Sciences & Technology, Universiti Malaysia Pahang, Lebuhraya Tun Razak, 26300 Gambang, Kuantan, Pahang Darul Makmur, Malaysia.
2 Chemistry Department, Faculty of Sciences, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor Darul Ehsan, Malaysia.
3 Department of Civil Engineering, Faculty of Engineering, University of Malaya, Jalan Universiti, 50603 Kuala Lumpur, Wilayah Persekutuan Kuala Lumpur, Malaysia.

Abstract. The capability of modified banana peel (MBP) to adsorb Fe (II) ions from synthetic ion solution has been studied. The acidic and basic solution strongly affected the Fe (II) ions adsorption. The effect of contact time and initial ion concentrations revealed that removal efficiency for 15 mg/L Fe (II) ions above 90 % after 2 hours. The size particles for MBP below 106 µm turned out to be the prefer size due to the highest percentage of ions adsorption. MBP appears to be a promising material to purify wastewater.

1. Introduction

The effluence of water bodies by pollutants or contaminants is called water pollution. Water pollution is an important environmental issue as water served a crucial role in all living thing activities. Water commonly is used by human for drinking, cooking, washing and propagates power energy supplies. Throughout nowadays growing of urbanization and modernization development, the water pollution issues cannot be avoided. It is serious when water pollution is caused by high concentration of heavy metals. Heavy metals such as arsenic, lead, mercury and cadmium are in high toxicity and do not biodegrade (Okafor et al., 2012). These toxic metals find its need in. The disposal of heavy metal waste by the industry, for example electroplating, alloy manufacturing and leather industry into the water body is harmful to human health and the aquatic life. In Malaysia, the water resources are mostly from river. Therefore, it is urgently needed to treat these waste before being disposed.

Iron is a naturally element and present in many types of rock, soil, sediments and groundwater. It is an important nutrient for algae and other organisms in fresh water (Vuori, 1995). However, high concentration of iron can cause diseases and syndromes, for instance hypertension, adverse DNA modification, liver damage, kidney dysfunction and lung damage or even cancer. The National Water Quality Standards for Malaysia stated that the level of iron metal in river should be less or equal to 1.0 mg/L.

Numerous research works have been carried out for wastewater treatment. Food wastes, like banana peels, orange peels, tea leaves and papaya seeds, are abundantly available and costless materials. Hence, the utilization of these food wastes in the wastewater treatment could significantly reduce the cost of wastewater treatment. It is an added advantage especially in the big scale of wastewater treatment. The objective of this work is to investigate the removal of Fe ion from aqueous solution by adsorption onto modified banana peel. Factors affecting adsorption, including the pH solution, initial ion concentration and contact time and particle size adsorbent have been examined.
2. Materials and methods

2.1. Materials
The materials used in this study were banana peels, Iron solution, sodium hydroxide, citric acid and deionized water.

2.2. Preparation of waste banana peels
The collected banana peels were washed and dried overnight. The dried banana peels were ground into powder and mixed with 1 M citric acid. After agitated above 2 hours, the slurry was dried overnight. The slurry was suspended in 5 M sodium hydroxide solution for 1 hour. Next, the slurry was washed and dried overnight. The treated banana peels were labeled as modified banana peels (MBP) and were preserved in desiccator for future use.

2.3. Adsorption study
Batch adsorption experiments were conducted by varying pH solution, contact time and initial ion concentrations and particle size adsorbent.

2.4. Characterizations
MBP were characterized by Fourier transform infrared spectroscopy (FT-IR).

3. Results and discussion

3.1. pH solution
pH solution is a significant condition that influence the Fe (II) ions uptake. This can be explained by the concentration of the ions affected the functional groups of the MBP and the degree of ionization of the ion solution throughout the adsorption process. MBP consists of specific active site which capable in binding the metal ions. Figure 1 depicts the percentage of Fe (II) ions uptake at different pH solution. The removal of Fe (II) ions exhibited less than 56 % in the acidic condition (pH below 6). Meanwhile, Fe (II) ions uptake only recorded less than 44 % in basic condition (pH above 8). Such low adsorption of Fe (II) ions phenomenon at acidic and basic condition are attributed to the metal ions become less stable because of surface complexation occur (Goher et al., 2015). The highest Fe (II) ions removal was at pH 6 solution with 60.84 %.

![Figure 1](image-url)  
**Figure 1.** Percentage of Fe (II) ion adsorption in various pH solution
3.2. *Initial ion concentrations and contact time*

There is a rapid adsorption for Fe (II) ions at the duration below 60 seconds for all three different ion concentrations ([Figure 2](#)). This is due to the accessibility of available binding sites or uncovered surface on the adsorbent for Fe (II) ions adsorption (Tasar et al., 2014). Thus, Fe (II) ions could easily interact with these sites. The Fe (II) ions adsorption reached equilibrium around 240 minutes for all three ion concentrations. Thereafter, a constant percentage of adsorption was found, which might attribute to all the surface of adsorbent were covered and it became difficult for Fe (II) ion from bulk to enter into the interior pores of the adsorbent (Ali et al., 2016).

![Figure 2](#). Percentage of Fe (II) ion adsorption at different ion concentrations and contact time.

3.3. *Effect of Particle Size*

The percentage of Fe (II) ions adsorption decreases from 71% to 52% when particle size of MBP was increased from \(<106 \mu m \text{ to } 630 \mu m\) ([Figure 3](#)). This phenomenon can be explained by the availability of greater adsorption sites were found on the surface of a smaller particle size of adsorbent. Therefore, higher amount of Fe (II) ions is adsorb on the surface of adsorbent.

![Figure 3](#). Percentage of Fe (II) ion adsorption at different particle size of MBP.
3.4. Characterization

FTIR spectra for MBP before adsorption process and after adsorption process show a slightly different absorption peaks (Figure 4). The dominant peak at 3400 cm\(^{-1}\) is attributed to O–H stretching vibrations in hydroxyl groups. The band observed at 2900 is assigned to asymmetric C–H which present in alkyl groups. The peak at 1600 cm\(^{-1}\) is assigned to carbonyl group (C=O), due to either the acetyl groups of hemicelluloses or the ester linkage of carboxylic groups of the ferulic and p-coumaric acids of lignin or hemicelluloses (Zohra et al. 2011). The band at 1370 cm\(^{-1}\) represents amide group. The hydroxyl, carbonyl and amide groups are the binding site which responsible to bind Fe ions (Aakanksha & Mane, 2013).

![FTIR spectra](image)

**Figure 4.** FTIR spectra of modified banana peel

4. Conclusion

Modified banana peel was successfully prepared. Findings from the experiments indicated that MBP are capable to remove Fe (II) ions from aqueous solution. The FTIR results indicated that the MBP presented different functional groups such as hydroxyl, amide and carbonyl, which may be a potential adsorption sites for Fe (II) ion removal. This study provides a waste-to-wealth route for application of food waste for industrial heavy metal wastewater treatment.

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Acknowledgements

The authors gratefully acknowledge the financial support from the grant of Universiti Malaysia Pahang (No. RDU1703179).