International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2020): 7.803

Removal of Heavy Metal Copper (II) from Aqueous Solution Using Chemically Modified Orange Peel

Kumar Joshi[1], Yashkumar Satasiya[2], Akash Patel[3], Momin Mustufa[4]

[1, 2, 3, 4] M.Sc. Students, Faculty of Applied Sciences, Parul University, Ahmedabad, India

Email: *kumarjoshi66[at]gmail.com*
yashsatasiya1234[at]gmail.com
patelaakash340[at]gmail.com
mominmustufa92[at]gmail.com

Abstract: ***The removal of copper (II) ions from the aqueous solution was the main aim of the project. The need for using cheap and eco-friendly adsorbent for the removal of copper (II) ions from aqueous solution is of paramount importance. Orange peel (OP) was modified using NaOH and methanol to prepare an orange peel adsorbent which was named Modified Orange peel (MOP). The adsorption behavior of Heavy metal (Cu^{+2}) were studied. Batch operations were carried out in liquid phase to observe the effect of various experimental parameters such as amount of adsorbent, contact time. The characterization of orange peel sample was also examined. The outcomes indicated that orange peel can be used as a good low-cost alternative for treatment of effluents containing Copper (II) in water.***

Keywords: Effluents, Environment, Heavy metals, Adsorption, Orange peel

1. Introduction

Organic and inorganic compounds are the main cause of pollution in our environment. Either deliberately through industrial emissions or accidentally through chemical and oil spills etc. being released in the environment. We can safely assume that it is due to the rapid industrialization during the last few decades which has been done without the concern of its impact; this puts the survival of living beings at stake. The heavy metals such as Cr, Cd, Pb, Ag, Cu, Ni, V, Co, Se and so on are introduced into the water streams from various industries viz. incinerators, electroplating, sludge disposal, chemicals, petrochemicals, fertilizers, paper industry, batteries etc. The metals once when released into the environment remains for a long duration and causes serious concern to the ecosystem as they leach persistently and slowly, and diffuse through the food chains. This, in turn, causes various health hazards such as kidney damage, high blood pressure, diarrhea, cancer and many other diseases. There are different methods for the treatment of industrial wastewater which have been reported in the literature. [1]Amongst these methods areneutralization, precipitation, ion exchange and adsorption. For low concentrations of metal ions inwastewater, the adsorption process is recommended for their removal. Biosorption of heavy metalions from aqueous solutions is a relatively new and promising process[2]. Many cellulosebased low cost biosorbents, plant based and agricultural waster are also noted in literature such as, heavy metal detoxification by Rice husk [3,4], Banana Peel [5,6,7], Corn Stalk [8]. Hemp fibers [9], coir pith [10] and orange peel [11, 12]

Copper (II) is one of most generally utilized metal found since ages. Copper being a fundamental component is utilized all things considered or as combinations. The significant ventures utilizing copper may be enrolled as electroplating, printing tasks, printed circuit board producing etc. Admissible limits for copper in the water bodies according to WHO rules and Central Pollution Control Board, India are 1 mg/L in consumable water just as in surface water bodies. The significant wellbeing impacts saw because of copper are reproductive and developmental toxicity, neurotoxicity, wooziness, and loose bowels [13, 14, 15].

Orange peel which is abundant in soft drink industries are usually treated as waste. The peel consists of manyfunctional groups, such as hydroxyland carboxyl, thus making it a potential adsorbent material forremoving metals [9].

As biosorbent, orange peelindicates high metal adsorption potential due to its highcontent of cellulose, pectin (galacturonic acid), hemicellulosesand lignin [16]

2. Methodology

The oranges were sourced from a local juice shop and washed thoroughly with distilled water to remove any adhering dirt and then sundried to remove little moisture. The moist orange peels were then dried in the oven for 12 hours. The peels were removed and grinded to a fine powder and then passed through a mesh sieve.

The powder was then treated with 200 ml methanol 100 ml 0.1N HCl and 100ml 0.1N NaOH and set aside for 24 Hours. Typical acid alkali and esterification was performed by adding methanol. The solution was heated for few minutes for the esterification process to finish. Basically, the activation by methanol involved an esterification of the carboxyl group of the biomass. Modified powder was then filtered and washed till a neutral pH was obtained. The filtrate was sufficiently dried in the oven and then was crushed using a grinder again. This modified orange peel was obtained which will be termed as MOP. MOP was then stored in air tight container for further use.

3. Results and Discussion

3.1 Analysis of Modified Orange Peel

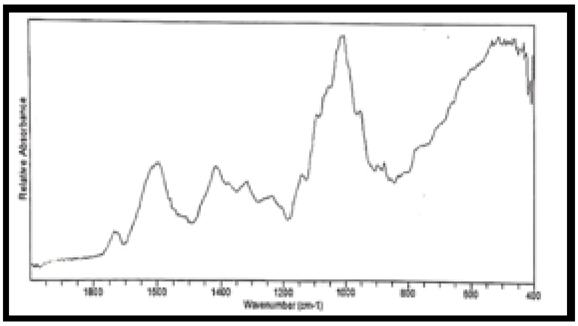

Figure 1: IR Analysis of Modified Orange Peel

Orange peel and lemon peel consist of soluble and insoluble monomers and polymers. Water soluble fraction contains glucose, fructose and sucrose, while pectin, cellulose, hemicellulose and lignin make up between 50% and 70% of insoluble fraction. [16-17] Sorption to biomaterials is attributed to active functional groups in the insoluble polymer fraction.

According to the OH test performed we can say that -OH group is present in the sample.

Intense band at 1616 cm^{-1}, assigned to the antisymmetric. stretching of the dissociated carboxyl groups (COO^-) Whereas the band of the ant symmetrical stretching mode of the COO groups in the orange peel appears at 1607 cm^{-1}, it is very likely that the stretching of the C=O bond in the protonated carboxyl groups (COOH) contributes to the band at 1645 cm^{-1} in the OP spectrumbands associated with the symmetrical stretching of the dissociated carboxyl groups (COO^-) are obtained at 1419 cm^{-1}.[18] Bands of medium intensity at 1234 cm^{-1} as well as broad intense bands in the spectral range between 1100 cm^{-1} and 1000 cm^{-1} are attributed to stretching vibrations of the C–O bonds in carbohydrate molecules(19). The spectra and confirmatory test clearly show that the dominant functional groups in the studied peels structure are protonated carboxyl groups (COOH), deprotonated carboxyl groups (COO-) and hydroxyl groups (OH).

Content Analysis: Various physical characteristic of the orange peel was investigated. The included the proximate analysis to find out volatile mater, moisture, ash content of orange peel sample.

Table 2: Content Analysis

Content	*Percentage*
Moisture content	2.5
Ash content	18.81
Volatile matter	12

Adsorption Experiment

For the experiment 0.5m mol/l solution of copper sulphate was prepared using distilled water to which different amounts of the biomass was added. The pH of all the solutions were controlled and set at an optimum of 5.5 for best results. The pH was controlled by using a small amount of dilute sodium hydroxide and hydrochloric acid. Different contact time were used at a constant temperature, the contact time of 10, 20, 30 minutes were used to check for maximum removal of the copper (II) ions. The Absorbance was checked with a UV Instrument at 740nm for maximum absorbance.

3.2 Adsorption Studies

1) Effect of Contact Time: The rate of adsorption is quite high initially; the rate of adsorption increases over time. The concentration of copper in the solution decreases till 60 mins which shows that the equilibrium time for adsorption for our experiment is 60 mins. It is most likely due to the fact that the saturation of active sites on the orange peel powder would not permit any more adsorption to occur. To explain this phenomenon, we can say by fact that initially, the quantity of the sites of adsorption in the orange peel is much high which allows the adsorption it take place readily. As time passes, the active sites now would be saturated with the copper ions, this would be there reason the rate of adsorption reduces.

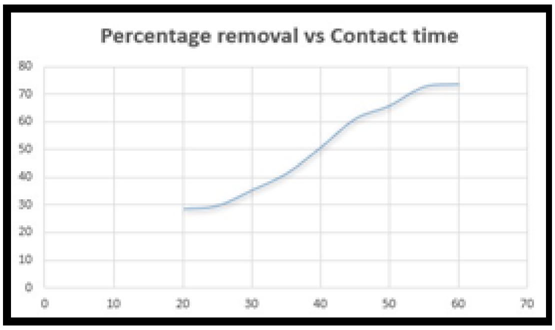

Figure 3: Percentage Removal vs Contact time

2) Amount of Adsorbent: The effects of adsorbent i.e. orange-peel sample dosage on the amount of copper removed expressed as percentage at initial concentration of 0.5 millimolar at 25degree was studied at different dosages of 0.125 g, 0.25g, 0.5g,1.0g,1.5g in a solution of volume 100ml. The figure depicts the percentage of removal of the copper from the solution. Once the 0.5g mark of adsorbent is reached, the adsorption almost becomes stagnant.

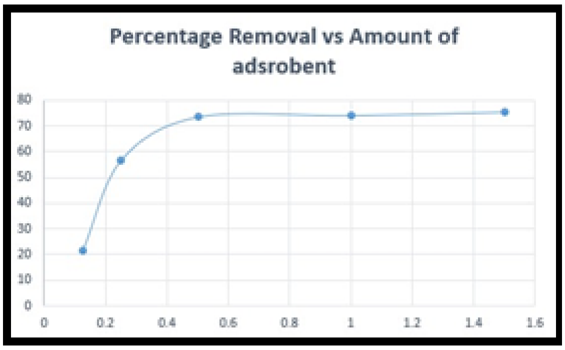

Figure 4: Percentage Removal VS Amount of Adsorbent

3) Effect of Temperature

The effect of temperature does not play an important role in the adsorption process. According to studies the temperature does not reduce the adsorption concentration. However slightly higher temperatures might increase the adsorption efficiency by a small margin, that being said the optimum temperatures which can be used is the ambient temperatures of 25-30 degree Celsius. All the experiments performed were at ambient temperature.

4. Conclusion

On the basis of good adsorption ability that modified orange peel showed for the metal ion Cu^{2+} suggests that the biosorbent which is available readily and is cheap has the potential to adsorb high amount of copper ions from the aqueous solutions. it might be also of use for the removal of $Cu^{2+}$from industrial waste water.

References

[1] A.Demirbas: J.Hazard.Mater. Vol.157 (2008), p.220
[2] N. Ahalya, T.V. Ramachandra, R.D. Kanamadi: J.Chem.Environ. Vol.7(2003), p. 71
[3] Sobhanardakani S, Parvizimosaed H, Olyaie E (2013) Heavy metals removal from wastewaters using organic solid waste—rice husk. Environ Sci Pollut Res 20:5265–5271
[4] Nakbanpote W, Thiravetyan P, Kalambaheti C (2000) Preconcentration of gold by rice husk ash. Miner Eng 13:391–400
[5] Memon JR, Memon SQ, Bhanger MI, El-Turki A, Keith R, Hallam Allen GC (2009) Banana peel: a green and economical sorbent or the selective removal of Cr (VI) from industrial wastewater. Colloids Surf B Biointerfaces 70:232–237
[6] Ajmal M, Rao RAK, Ahmad R, Ahmad J (2000) Adsorption studies on Citrus reticulate (fruit peel of orange): removal and recovery of Ni (II) from electroplating wastewater. J Hazard Mater 79:117–131
[7] Sahu MK, Mandal S, Dash SS, Badhai P, Patel RK (2013) Removal of Pb (II) from aqueous solution by acid activated red mud. J Environ Chem Eng 1(4):1315–1324
[8] Zheng L, Zhu C, Dang Z, Zhang H, Yi X, Liu C (2012) Preparation of cellulose derived from corn stalk and its application for cadmium on adsorption from aqueous solution. CarbohydrPolym 90:1008–1015
[9] Tofan L, Teodosiu C, Paduraru C, Wenkert R (2013) Cobalt (II) removal from aqueous solutions by natural hemp fibers: batch and fixed-bed column studies. Appl Surf Sci. doi:10.1016/j. apsusc.2013.06.151
[10] Parab H, Joshi S, Shenoy N, Lali A, Sharma US, Sudersanan M (2006) Determination of kinetic and equilibrium parameters of the batch adsorption of Co(II), Cr(III) and Ni(II) onto coir pith. Process Biochem 41:609–615
[11] Dhakal RP, Ghimire KN, Inoue K (2005) Adsorptive separation of heavy metals from an aquatic environment using orange waste. Hydrometallurgy 79:182–190
[12] Feng N, Guo X, Liang S, Zhu Y, Liu J (2011) Biosorption of heavy metals from aqueous solutions by chemically modified orange peel. J Hazard Mater 185:49-54
[13] WHO, World Health Organization, Guidelines for drinking water quality, 1(1993) 52.
[14] Owamah, H.I. 2014. Biosorptive removal of Pb (II) and Cu (II) from wastewater using activated carbon from cassava peels. J. Mater. Cycles Waste Manage. 16: 347–358
[15] Kurniawan, T.A, Chan, G.Y.S, Lo, W.H, Babel, S. 2006. Comparison of low cost adsorbents for treating wastewaters laden with heavy metals. Science of the Total Environment 366: 409-426
[16] Namasivayam, C., Muniasamy, N., Gayatri, K., Rani, M., and Ranganathan, K. (1996). "Removal of dyes from aqueous solutions by cellulosic waste orange peel," Bioresour. Technol. 57(1), 37-43. DOI: 10.1016/0960-8524(96)00044-2
[17] Mostaedi, M. T., Asadollahzadeh, M., Hemmati, A., and Khosravi, A. (2013). "Equilibrium, kinetic, and thermodynamic studies for biosorption of cadmium and nickel on grapefruit peel," J. Taiwan Inst. Chem. Eng. 44(2), 295-302. DOI: 10.1016/j.jtice.2012.11.001
[18] A.B. Perez Marin, M.I.Agilar, V.F. Meseguer, J.F. Ortuno, J. Saez, M. Llorens, (2009), Biosorption of chromium (III) by orange waste: Batch and continuous studies, Chem. Eng. J. 155 (2009), pp. 199-206.
[19] N. Feng, X. Guo, S. Liang, Adsorption study of copper (II) by chemically modified orange peel, J. Hazard. Mater. 164 (2009), pp. 1286–1292.
[20] Sahu, Roshan. (2015), 'Removal of Congo Red Dye from water using Orange peel as an adsorbent', NIT ROURKELA