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REVIEW ARTICLE

REMOVAL OF HEAVY METAL BY USING DIFFERENT FRUIT PEELS, VEGETABLE PEELS AND ORGANIC WASTE - A REVIEW

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Abstract

Heavy metal pollution adversely affects all living organism. There are various conventional methods used for removing heavy metal contamination. Present study used the green technology for removal of heavy metal. The various fruits and vegetables peels are used as pineapple peels, potato peels, citrus fruits peels, orange peels, pomegranate peels, banana peels, tomato peels, etc. The extent of removal of heavy metals was found to be dependent on sorbent dose, initial concentration, pH and temperature. The adsorption follows first order kinetics and all these processes are generally endothermic showing mono-layer adsorption. The present study has reviewed the removal of heavy metals from various fruits and vegetables peels.

INTRODUCTION

Heavy metals become a chronic problem globally. Industrialization and urbanization has increased heavy metal pollution drastically which adversely affects all living organism. Some of the pollutants like lead (Pb), arsenic (As), mercury (Hg), chromium (Cr), nickel (Ni), barium (Ba), cadmium (Cd), cobalt (Co), selenium (Se), Vanadium (V), oils and grease, pesticides etc. are very harmful and poisonous even if present in very small amounts like ppb (parts per billion range (R.Verma and P.Dewivedi, 2013).

The bio-toxic effects of heavy metals refer to the harmful effects of heavy metals to the body when consumed above bio-recommended limits. Some of the general symptoms associated with cadmium, lead, arsenic, mercury, zinc, copper and aluminum poisoning are gastrointestinal (GI) disorders, diarrhoea, stomatitis, tumor, haemoglobineria causing a rust red color to stool, ataxia, paralysis, vomiting and convulsion depression and pneumonia when volatile vapor and fumes are inhaled (Mccluggage,1991). Traditionally, heavy metal containing waste water is treated with different methods such as reverse osmosis, solvent extraction, membrane filtration, reduction and precipitation, bio-sorption, sorption in fixed bed column, ion exchange and other processes (M.A. Salmand and R.M.Mohamed, 2013). Owing to the high and difficult procurement of activated carbon, efforts are being directed towards finding efficient and low cost materials.

LITERATURE REVIEW

Polymerized onion skin with formaldehyde(P.Kumar,S.S.Dara,1981)Waste wool (M.Friedman,M.S.Nasri,1972), Mfriedman,A.C.Waiss,1973), peanut skin (J.M.Randell etal 1975) modified bark (J.M.Randell etal 1975 J.M.Randell etal 1978, J.M.Randell etal 1976),Barley straw(P.Kumar,S.S.Dara(1980)have been studied removal of nickel by absorption using solid residue from olive mill product (V.J. Larsen, H.Sci erup (1981), Mongifera Indica seed shell (S.H.Gharaibeh etal 1998),(M.Ajmal et al 1998),coal based absorbent ((W.Guangju 1998), burned clay and root (D.K. Singh (1992)furnace gas cleaning sludge (A.Donali et al (1192), hydrous oxides of iron (G.Jallan,G.S. Pandey (1992) has been reported. In this paper, removal of some heavy metals from water by using vegetables and fruits has been reviewed.

Orange Peel:

Mohammad Ajmal, et al (200) studied the use of fruit peel of orange for removal and recovery of Ni (II) from electroplating waste water. He also studied the ability of fruit peel of orange to remove Zn, Ni, Cu, Pb and Cr from aqueous solution. The absorption was in the order Ni (II) > Cu(II) > Pb(II) > Zn(II) > Cr(II). The adsorption follows first order kinetics. The process is endothermic and follows Langumir and Freundlich isotherm. The absorbed Ni (II) can be recovered using 0.05 M HCl solution. However the recovery of Ni (II) by column operation is higher (95.8%) as compared to batch process (76%).The spent absorbent can be regenerated and reused making the absorption process more economical. R. Z,Yarbay Sahin et al 2013 study the use of low cost, locally available and eco-friendly absorbent, tomato plant waste activated carbon.
The activated carbon were characterized using elemental analysis scanning electron microscopy, tomato waste used has been successfully converted to activated carbon at two different temperatures. Prepared activated carbon showed high cobalt adsorption was found to be PH dependent. Effective absorption was occurred at PH 8.The percentage removal was decreased with initial concentration. The highest Co (II) removal was found to at 30^{o}Cas 99.96% by using temperature two (AC-II).The pseudo first order and pseudo second order kinetic models were used to describe the kinetic data. It was found that the data fitted well to Freundlich model.

Banana Peel:

KKIU Aruna Kumara et al 2013 revealed by laboratory investigations, banana peel contains pectin (10-21%0, Lagnin (6-12%),cellulose (7.6-9.6%) and hemicelluloses (6.4-9.4 %)and also investigated that banana peel is capable of absorbing 5.71, 2.55, 2.800, 6.88, 7.97 and 5.80 mg/g of Ca2+, CO2+, Cu2+, Ni2+, Pb2+ and Zn2+ respectively from aqueous solution. Absorption capacity is however dependent upon several factors including solution pH, dose of absorbent, metal concentration, contact time and shaking speed.
Mrinalini Kanyal and A. Ashok Bhatt studied the removal of heavy Metals from water (Cu & Pb) using household waste as an absorbent such as chicken eggshells, Banana Peels and pumpkin powder. The effects of various parameters such as pH agitation speed and contact time was studied and good results were obtained at pH 7, 100 rpm and 90 min of contact time. The size of the absorbent was at a very small scale hence which helped in the efficiency of absorption, also these household waste are economical, easy to find and inexpensive making this process sustainable. The result indicate that usage of household waste such as these can be used as a good bio-sorbent for removal of heavy metals on a large scale.
Renata et al (2011) studied solid phase extraction of copper and lead from river water using minced banana peel above pH 3.The medium was characterized by FTIR which showed absorption bonds of carboxylic and amino groups at 1730 and 889 cm-1 respectively. The absorption isotherm fitted by Langmuir model showed maximum absorption capacities of 0.33 and 0.20 mol/g for Cu (II) and Pb(II) respectively. Several other scientist also worked on Banana peel (Ashraf et al.,2011;Castro et al;2011;Hossain et al2012).

Pomegranate Peel:

Masoud Rohani Moghada metal studied pomegranate peel carbon bio sorbent for removal of Fe(II) from aqueous solution. The kinetic studied proved that the first order kinetics was the best applicable model. The maximum adsorption potential of pomegranate peel absorbent for Fe (II) removal was 18.5 mg/g, pH 6 for 1 g bio-sorption at 29^{o}C. Thermodynamic parameters showed that the adsorption process was exothermic and spontaneous. The absorption studies were carried out with alteration in the parameters such as pH, contact time, sorbent weight, metal concentration and temperature.

Pineapple Peel:

Mohammed et al uses pineapple peel for removal of sofranin-O from waste water. The process was carried out in a batch with different initial concentration of the absorbate. The amount of absorbent dose used was varied as well as pH and contact time. Maximum absorption capacity was reached after 90 min, during which the absorbate were in contact at 29^{o}C. The result obtained fitted Freundlich and Langmuir model.

S. No.	Adsorbent Name	Metal Name for Removal	Max Absorption	Temperature	pH
1.	Orange fruit (citrus reticulate)	Ni, Cu, Pb, Zn, Cr	96%	50 ^{O}C	6
2.	Tomato Waste	CO(II)	99.6%	30 ^{o}C	8
3.	Banana Peels	Pb(II)	74%	---	7
4.	Pumpkin	Pb(II)	74%	---	7
5.	Pomegranate	Fe(II)	---	29 ^{o}C	6
6	Pinapple	Sofranin-O	43%	29 ^{o}C	________

Several other peels/organic waste:

Papaya wood (Saeed et al:2005)'grape stalk waste (Villaescusa et al.,2004) neem bark (King et al.,2007), neem biomass (Arshad et al 2008), tea-waste (Malkoc and Nuhoglu,2007; Kamsonlian et al 2011a), sawdust (Garg et al.,2004;Memon et al., 2005), tamarind bark (Prasad and Abdulsalam, 2009), tamarind hull (Verma et al., 2006), potato peel waste (Ahalya et al., 2005), maize corn cob, jatropha oil cake, sugarcane bagasse (Garg et al., 2007), rice husk (Kumar and Bandyopadhyay, 2006), rice straw (Gao et al., 2008), wheat straw (Robinson et al., 2002), wheat shells (Bulut et al., 2007), wheat bran (Sulak et al., 2006), maize leaf (Babarinde et al., 2006), wood and bark (Mohan et al., 2007), teak leaf powder (King et al., 2006), rubber leaf powder (Hanafiah et al., 2006), pine bark (Al-Asheh et al., 2000), saltbush (Sawalha et al., 2005), and olive pomace (Pagnanelli et al., 2003), orange peel (Kamsonlian et al., 2011b).

CONCLUSIONS

Various low cost absorbent presented and studied in this paper are very useful for the treatment of waste water, soil for removal of either heavy metals or dyes.
The low cost absorbent used are very effective in either treatment or removal. The efficiency of these fruit and vegetable peels is from 43% to 96%, temperature range is 50^{o}C to 29^{o}C , concentration range is 21.7 to 50 mg/L, the effective pH is 6-8.These bio-sorbents are cost effective and economically cheaper. Further it was found that the data was based on batch adsorption process. Hence there is a scope for more research for the evolution of the technical data and economic feasibility based on the system of continuous and pilot scale studied for treatment of large quality of water and effluents.
These low cost absorbents are easy available and regenerated by treatment with alkali and for complete removal of heavy metal they are burn off.

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