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Research Article

SORPTION OF HEXAVALENT CHROMIUM BY VARIOUS BIOSORBENTS

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Abstract: As Cr(VJ) is potential carcinogen, mutagen and tartogen, considering the seriousness of the problem and in search of cost effective treatment technique author took plant based waste for the treatment of Cr. Where in fruit peels, vegetable peels, few leaves, few petals and pulp was taken in biosorption study and found that banana peel and onion peel were good in sorption of Cr(100% in first contact time that is 15 min).

Key words: *Biosorption, Chromium, fruit peels and vegetable peels*

INTRODUCTION:

At least 20 metals are classified as toxic and half of these are emitted into the environment in quantities that pose risks to human health[1]. Chromium has both beneficial and detrimental properties. Two stable oxidation states of chromium persist in the environment, Cr (III) and Cr (VI), which have contrasting toxicities, mobility's and bioavailability. Whereas Cr (III) is essential in human nutrition (especially in glucose metabolism), most of the hexavalent compounds are toxic, several can even cause lung cancer. While Cr (III) is relatively innocuous and immobile, Cr (VI) moves readily through soils and aquatic environments and is a strong oxidizing agent capable of being absorbed through the skin[2]. Chromium and its compounds are widely used in electroplating, leather tanning, cement, dyeing, metal processing, wood preservatives, paint and pigments, textile, steel fabrication and canning industries these industries produce large quantities of toxic wastewater effluents[3]. The maximum concentration limit for Cr (VI) for discharge into inland surface waters is 0.1 mg/l and in potable water is 0.05 mg/l.

A wide range of physical and chemical processes is available for the removal of Cr (VI) from wastewater, such as electro-chemical precipitation, ultra filtration, ion exchange and reverse osmosis[4 5 6]. A major drawback with precipitation is sludge production. Ion exchange is considered a better alternative technique for such a purpose. However, it is not economically appealing because of high operational cost. Adsorption using commercial activated carbon (CAC) can remove heavy metals from wastewater, such as Cd[7] Ni[8] Cr[9] Cu[10]. However, CAC remains an expensive material for heavy metal removal.

Natural biopolymers are industrially attractive because of their capability of lowering transition metal-ion concentration to parts per billion concentrations. Natural materials that are available in large quantities or certain waste from agricultural operations may have potential to be used as low cost adsorbents, as they represent unused resources, widely available and are environmentally friendly[11]. In Malaysia, oil palm is the most important commercial crop. The explosive expansion of oil palm plantation has generated enormous amounts of vegetable waste. It was reported that Malaysia currently produces about 30 million tons annually of oil palm biomass, including trunks, fronds, fruit waste and empty fruit brunches. Of these, about two million tons of fruit shell (or endocarp) is generated annually[12]. Preliminary studies have shown that it is feasible to prepare chars with sufficient densities and high porosity from oil palm fruit waste[13]. The exchange/sorption properties of palm oil shell are due to the presence of some functional groups, such as carboxylic, hydroxyl, and lactone, which have a high affinity for metal ions[14]. In recent years, development of surface modified activated carbon has generated a diversity of activated carbon with far superior adsorption capacity. The use of palm oil shell with surface modification to improve its metal removal performance would add its economic value, help reduce the cost of waste disposal, and most importantly, provide a potentially inexpensive alternative to existing commercial activated carbon.

Among the many other low cost absorbents identified[15 16 17] chitosan has the highest sorption capacity for several metal ions[18]. Chitin (2-acetamido-2-deoxy-b-D-glucose-(N-acetylglucan) is the main structural component of molluscs, insects, crustaceans, fungi, algae and marine invertebrates like crabs and shrimps[18 19].

MATERIALS AND METHODS

Different plant based materials were taken, shade dried and used for adsorption studies. They are as follows:
Ananas comosus, Musa paradisca, Citrus reticulate, Citrus lemon, Citrullus vulgaris, Punica granatum, Mangifera indica, Achras Zapota Luffa acutangua, Legenaria siceraria, Allium cepa, Solanum tuberosum, Daucus carota, Cucumis sativus, Tabanemontana divaricata, Acalypha indica, Coriandrumsativum, Trigonella Foenum-graceum, Hibiscus rosasinensis, Codiacumspp, Gliricidirepium seeds, Tamarindus indicus, Drumsticks Seed.

BIOSORBENT PREPARATION: 2 gm of shade dried plant based material was taken like fruit peels, leaves, fruits etc, and grinded them properly so as to get the uniform size of the particles by severing them through mesh size (2mm). Then poured the contents in the column and added with 100 ml of 60 ppm, chromium Solution and properly mixed.

ADSORPTION STUDEIS: The column was used for this study. The solution was collected regularly at every half an hour with a flow rate of 1 ml/ min upto 4 hours then 24^{th} hour reading was taken as last reading.

ESTIMATION OF CR: This was estimated as metal adopted by APHA 1987. 250 mt of D.P.C. was dissolved in 50 ml Acetone and used as a reagent. 02NH2 SO4 was used to the reagent complex compound formation with Cr 1 ml of 2NH2SO4 5 ml of DPC reagent 1 ml of sample (Cr containing sol) and 9 ml of D.W. was added and developed pink colour was read at 540 mm in spectrophotometer.

RESULTS AND DISCCUSION:

Fruit Peels :

Influence of different fruit peels on the absorption by column technique was determined with 15 minutes interval and presented in the table 1, it was clear that the influence on the absorption of chromium was varied among different fruit peels. The chromium adsorption was maximum (95.22%) as its 15 minutes contact time for *Musa paradisica* (Banana peel) peel and in the next incubation (30 minutes) showed 100 percent. The peels of *Acrus sapota* (Sapota) were also equally good in chromium absorption showed 67.23 percent at its 15 minutes of incubation time and after 30 minutes it showed the maximum adsorption rate (98.22%). The subsequent contact time that it 45 minutes was efficient and showed their 100 percent absorption. The total absorption of chromium by *Cirtus reticulate* (Orange) peel was witnessed after 60 minutes of contact time, where initial 3 contact times showed the range of percentage of chromium absorption from 69.98 to 86.56 the range of absorption of *Citrus aurantium* (Battaya) peel was from 67.99 to 99.99 percent after 1 hour of contact time and subsequent estimations showed 100 percent absorption of chromium by these fruit peels. The fruit peels of *Ananas comosus* (pine apple) were moderate in the absorption of chromium, showed their 95.17 percentage absorption of chromium. The fruit peels of *Punica granatum* (Pomegranate) and *Mangifera indica* (Mango) were not effective and resulted for less chromium absorption. The range of chromium absorption by *Punica granatum* (Pomegranate) was 57.56 to 80.12 percentage after 2 hours contact time, while *Mangifera indica* (Mango) peel showed its ranged of absorption from 46.38 to 69.12 percentage after 90 minutes of contact time and further incubation could not show any impact.

Vegetable Peels:

In another experiment efficiencies of chromium absorption by different vegetable peels have under taken by the column experiment. From the table it was evident that, among the studies vegetable peels, *Allium cepa* (Onion) peel is the most efficient and adsorption was 100 percent at 15 minutes of contact time in the column. Next best absorber is *Langenaria* (bottle guard) peel, which showed 89.12 percent at 1.15 hr of contact time. When the contact time increased to 2 hours the adsorption rate was decreased and reached to 86.39 percentages. The adsorption was 74.39 percent for *Luffa acutangua* (Ridgeguard) peel at 2 hours of contact time and in earlier contact period adsorption capacities were lie between 55.75 to 72.25 percent. Both *Cucumis sativus* (Keera) peel and Solamum tuberosum (Potato) peel were similar in their adsorption capacities of chromium at 1.45 hr contact period (67.12 to 61.74%). The adsorption capacity *Cucumis sativus* (Keera) was gradually; increased from 55.07 to 67.12 percentages, where as adsorption of chromium for *Solanum tuberosum* (Potato) peel 35.56 percentage at 15 minutes of contact time. The adsorption was slow up to 45 minutes and increased 1 hour onwards. *Daucus carota* (Carrot) peel is not a good adsorber of chromium and showed the adsorption 27.12 percentage at 1.45 minutes.

Leaves:

From the table, the efficiencies of different leaves on chromium adsorption was studies and the leaves of *Achalypha indica* showed 100 percent absorption at 1.15 hrs of contact time, and was persistent till the last contact time. The next best bioadsorber is *Psidium guava* (Guava) leaves, where the adsorption of chromium was 29.66 percent in 15 minutes of contact time and reached upto 65.04 percent in its last contact time. Croton species leaves or moderate bioadsorber of chromium and its chromium adsorption was 58.91 percent at 1.45 minutes contact time. Where *Musa paradisica* (Banana) peel is efficient bioadsorber of chromium but leaves are proved to be poor in adsorption. They could adsorb up to 35.59 percent at 1.15 minutes. This was decreases slightly and reached up to 34 percentage. *Hibiscus rosasinesis* (Hibiscus) leaves and *Trignella foenum* (Menthi) leaves showed similar percentage of adsorption of chromium at 2 hours of contact time. *Coriandrun sativum* (Coriander) leaves and *Tabernum montanum* (Nandhivardhanam) leaves are not useful for bioadsorption. They adsorb around 15 percent at 1 hour of contact time (last four leaves values were not mentioned in table).

Miscellaneous:

From the table it was noted that all the studies biomass materials are good adsorber of chromium and among them *Tamarindus indicus* (Tamarid) is a good adsorber of the chromium. At the first collection time (15 minutes) adsorption was 93.67 percent and increased to 100 percent at 45 minutes of contact time. *Moringa pterygosperma* (Drumsticks) are also equally good in adsorption of chromium in 15 minutes of contact time the adsorption was 100 percent. The adsorption capacity of *Glirisidium spcies* seeds is 48.51 percent at 15 minutes contact time and reached to 100 percent at 45 minutes of contact time. The adsorption capacity flowers were ranged from 68.83 to 99.9 at 15 minutes contact time and to 1 hour contact time and at 1.15 minutes of contact time the percentage of chromium adsorption was 100 percent.

The dried and fresh peels of *Citrus reticulate* (Orange) with their high content of cellulosic and pectic material was efficient enough to adsorb high quantities of Cr

(VI) from industrial wastewaters. In the present study the *Citrus reticulate* (Orange) peel showed theirs maximum adsorption of chromium after 45 percent potentiality.

Phytoremediation has gained importance in chromium remediation, which can be achieved by phytoextraction, rhizofiltration, and phyto-detoxification[20]. Two low cost sorbents, grape stalks and yohimbe bark wastes were used to remove Cr(VI) and Cr(III) from aqueous solutions. Batch experiments were designed to obtain Cr(VI) and Cr(III) sorption data. The mechanism of Cr(III) and Cr(VI) removal and Cr(VI) reduction to Cr(III) by the two vegetable wastes, has been investigated[21]. The adsorption capacity of the composite biosorbent was evaluated by measuring the extent of adsorption of chromium metal ions from water yielded the following ultimate capacity values for the coated biosorbent on a per gram basis of chitosan: 154 mg Cr/g. Bioconversion of Cr (VI) to Cr (III) by chitosan was also observed and had been shown previously in other studies using plant tissues and mineral surfaces[22].

CONCLUSIONS:

As India is developing country most of the industries cannot afford the investment on different treatment plants and recurring expenditure on it. So, this is cost effective and better treatment method which can bring about the effective Chromium reduction. In this technique the material used is plant based waste, can get to the 0 cost. Still research is needed to put this technique in to practice.

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