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ADSORPTIVE REMOVAL OF HEAVY METALS AND DYE USING GROUND NUT (ARACHIS HYPOGEA)

KEYWORDS: HEAVY METALS; ARACHIS HYPOGEA; POLLUTION; BIOSORPTION

Bismi Sonia Nazeer

Guest Lecturer, Department of Botany, Bishop Moore College, Mavelikkara

ABSTRACT Rapid industrialization and unabated pollution due to heavy metals is one of the gravest problems now which are toxic to all forms of life including humans. Heavy metals are non-biodegrable and have biomagnification potential which results in severe ecological and health implications. The present study is an attempt for adsorptive removal of heavy metals and dye using ground nut (Arachis hypogea). The results indicate that it is a promising candidate and future works in this regard was recommended.

INTRODUCTION

Pollution has incredible impact on humans and environment with unprecedented catastrophic implications both epidemiologically and ecologically. Among the pollutants, heavy metals and dyes has an outstanding role as pollutants due to its higher toxicity and biological effects (Duruibe et al., 2007). Heavy metals present in the aquatic realm has long lasting and more in depth effects due to their mobility, toxicity and non-biodegradable nature. The biological and health effects of heavy metals are different like cancer (As and Cd), mutations and genetic damage (Hg), brain and bone damage (Cu, Pb and Hg) (Jaishankar et al., 2004,). The biomagnification potential of heavy metals makes the situation more vulnerable with unimaginable biological effects which are deleterious too to life. Heavy metals and dyes are the major contributors of contamination of aquatic realm (Rashmi and Pratima, 2013). Majority of the chemical methods employed to clean heavy metals and dyes are not effective . There are various methods to remove heavy metals and dyes including chemical precipitation, membrane process, ion exchange, liquid extraction and electrodialysis (Gunatilake, 2015) which are non-economical and have an array of disadvantages too. The present study is an attempt to check the biosorbtion potential of Arachis hypogea powder to remove heavy metals and dyes.

MATERIALS AND METHODS

Adsorbent preparation

Groundnut shell were ground separately and sieved to obtain particle size of 0.6mm.The sieved adsorbents were washed with distilled water to remove dust and kept in an oven at 650C for 24 h which are used for the experiments.

Adsorbate

Stock solutions of Chromium (IV) were prepared by dissolving 0.5gm of Potassium dichromate ($K_2C_2O_7$) in 1000 ml distilled water. Different initial concentrations of metal ions were prepared by diluting the stock solutions. The pH was maintained using 0.1N HNO_3 and 0.1NaOH solutions.

Batch adsorption studies

The batch adsorption studies were performed at room temperature. The biosorption capacity was determined by contacting 10mg/l of the adsorbate solution in a flask at optimum temperature in heavy rotary shaker for a fixed time at 150 rpm and the adsorbant was separated .

Batch experiments

The experiments were carried out under constant shaking of 100ml of simulated solutions in conical flasks in heavy rotator shaking apparatus (150 rpm). Samples were withdrawn after a definite time interval at constant temperature and filtered through Whatman No. 41 filter paper which was further analyzed and compared using UV visible spectrophotometer. The percentage of dye removal was calculated using the formula,

$\frac{Co-Ci}{Co}$ X 100, where Co is the initial dye concentration, Ci is the final dye concentration after adsorption. Effects of adsorbant dose, contact time and pH were also studied. The adsorption isotherm data was also incorporated using Langmuir and Freundlich models.

RESULTS

The results obtained in the study were given in Figures 1 to 6 and Tables 1 & 2. The contact time adsorption studies revealed that the colour removal efficiency increases with increase in contact time and then it become constant. The optimal contact time to attain equilibrium was found to be 15 minutes in the study. The uptake of methylene blue by ground nut shell is 67% with low adsorption at acidic condition. The amount of dye adsorbed varied with the adsorbent concentration. The Langmuir and Freundlich models are given in Table 1 & 2. The R_L values indicating types of Langmuir isotherm was given in Table 3. The results of Freundlich isotherm modeling was given in Table 4.

DISCUSSION

Recently, the adsorption process has been acknowledged as an efficient and cost-effective method for the removal of heavy metals from polluted water as it extends flexibility. The recalcitrance and persistence of heavy metals in the environment, especially in aquatic realm has provoked several researches in this line globally. The present study was also an attempt in this line so as to evaluate the biosorbtion potential of *Arachis hypogea* powder to remove heavy metals and dyes.

The results of the present study clearly indicate that *Arachis hypogea* powder was a good adsorbent of Methylene blue and Chromium. However, the property was depended on several parameters like dose of adsorbent, pH, time contact and several other indirect factors. The obtained results are also in agreement with earlier works published (Singh and Ali, 2012; Singh, 2013). Singh *et al.* (2014) showed that adsorption capacity of agricultural residues like *Arachis hypogea* shell in

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different combinations is much better, attesting that the prepared biosorbents have potential in remediation. The potential of *Arachis hypogaea* shells for environmental remediation was well illustrated by Muhammed (2014) as it contains high level of Ca, Mg, K, P, Na, S and the micro-nutrients Mn, Cu, Zn, Mo, B, Cl. and Fe. Moreover the Thermo-gravimetric analysis also points out its potential for use as an efficient biosorption material to minimize industrial pollution. The use of peanut hulls (*Arachis hypogaea* Linn for biosorption of Cr (VI) from aqueous solutions was also reported earlier (Sharma *et al.*, 2015).

Peanut (*Arachis hypogaea* Linn.) belonging to Leguminaceae family and sub family Papilionioceae is being one of the highest produced food in the country with large amounts of waste which has no commercial value. The biosorption potential of these Peanut hulls is promising due to the low cost, higher adsorption capacity, possibility of availability of function groups such as hydroxyl, carbonyl, carboxylic etc. due to high cellulose (44.8%) and lignin (36.1%) content, which favours biosorption of heavy metals (Olivereira *et al.*, 2010).

CONCLUSION

The present investigation revealed that peanut (*Arachis hypogaea* Linn.) can be used as an inexpensive, excellent biosorbent for the removal of Chromium (VI) and Methylene Blue from aqueous solutions under controlled conditions. From the observations in the study, it can be concluded that peanut (*Arachis hypogaea* Linn.) has considerable biosorption capacity, available in abundant, non-hazardous agro material can be used as an effective indigenous material for treatment of polluted water containing heavy metals and dyes.

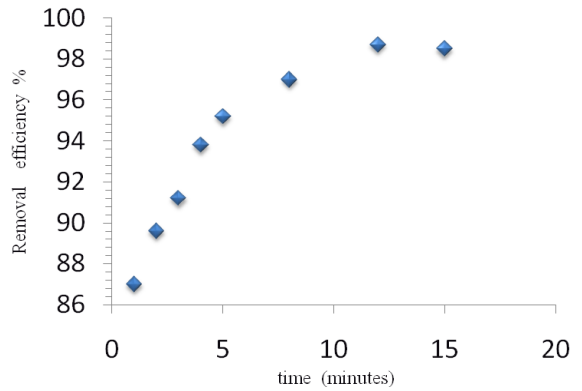

Fig 1: Effect of contact time in MB

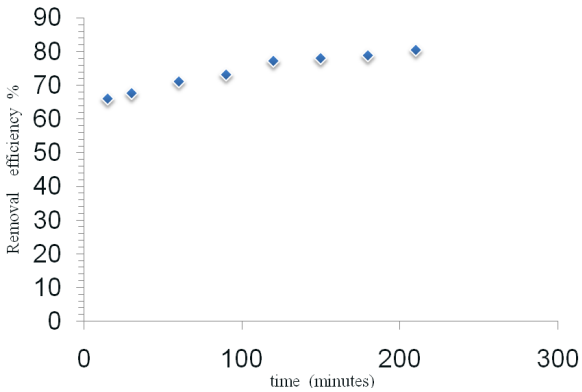

Fig 2: Effect of contact time in Chromium

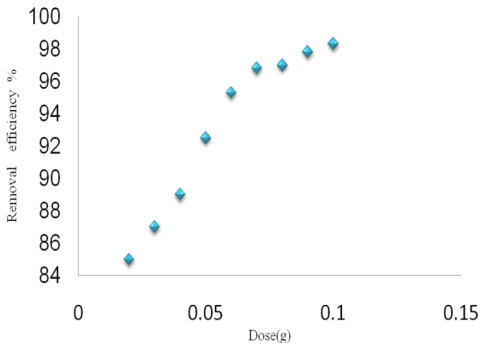

Fig 3: Effect of dosage in MB

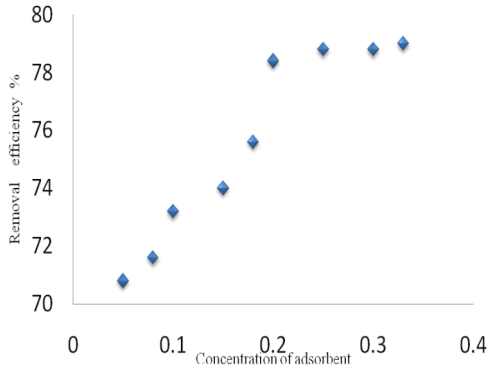

Fig 4: Effect of dosage in Chromium

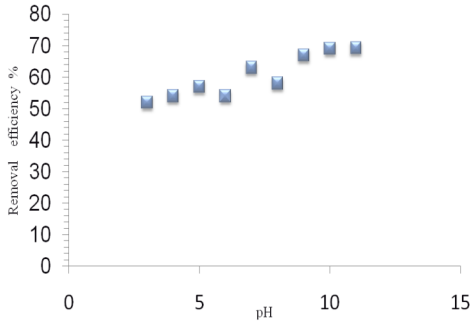

Fig 5: Effect of pH in MB

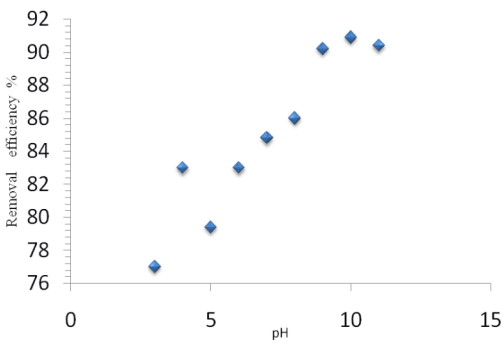

Fig 6: Effect of pH in Chromium

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Table1: Results of Langmuir isotherm

Adsorbent	Dye/Metal	R^2	α_L	K_L	R_L
Ground nut	MB	0.977	0.905 x 10^{-3}	0.00678 /mg	0.944
Ground nut	Cr	0.9926	0.103 x 10^{-2}	0.00122	0.9939

Table 2: Fredluich isotherm results

Adsorbent	Metal & Dye	a	b	R^2
Ground nut	MB	147.4	0.1335	0.977
Groundnut	Cr	818.3	0.85	0.9926

Table 3: RL values indicating types of Langmuir isotherm

R_L value	Adsorption
$R_L > 1$	Unfavorable
$R_L = 1$	Linear
$0 < R_L < 1$	Favorable
$R_L = 0$	Irreversible

Table 4: Results of Freundlich isotherm parameters

Adsorbent	A	b	R^2
Ground nut shell	147.4	0.1335	0.977

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