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Azadirachta Indica (Neem) Leaf Powder Used As A Natural Adsorbent For The Removal Of Chromium Cr (VI) From An Aqueous Solutions

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ABSTRACT: Chromium (VI) has been found to be very toxic metals present in water obtained from almost all industrial effluents. Sustainability of health depends upon the pure form of water. However groundwater may be exposed towards to contamination by various anthropogenic activities such as agricultural, domestic and industrial activities. The effluents of tannery industries are the major sources of chromium contamination in the groundwater and surface water. In most of the sub-urban areas ground water is the major source of drinking water. For human beings long term exposure to chromium is very detrimental. In this present investigation, Azadirachta indica (neem) leaf powder which is a natural material used as an adsorbent for the removal of chromium from aqueous solutions. The equilibrium studies are systematically carried out in a batch process, covering various process parameters that include adsorbent size and dosage, agitation time, volume of aqueous solution, initial chromium concentration, and pH of the aqueous solution. Adsorption behavior is found to follow Freundlich and Langmuir isotherms.

Keywords: Adsorption, herbal and low-cost adsorbent, eco-friendly.

INTRODUCTION: The presence of heavy metals water has become a major problem in today's world due to its direct effect on all living organisms especially on human beings. If these present in quantities above a certain permissible limit, they can cause various short and long-term hazardous and harmful effects, such as shortness of breath and lungs, coughing, and wheezing leading to gastrointestinal effects, such as abdominal pain, vomiting, hemorrhage, and neurological effects. Cr (VI) can also act as a carcinogen.[3] Industrial pollution carries to be a potential threat affecting the water. The discharge of non-biodegradable heavy metals into water stream is almost everywhere and hazardous because the consumption of polluted water by living beings causes various health problems. Waste streams containing various heavy metals such as Pb, Cd, Cr, Cu, Zn, Ni are often encountered in various chemical and biochemical industries. Among these heavy metals, pollution by chromium (Cr) is of considerable concern. Chromium (Cr) is widely used in electroplating, metal finishing, leather tanning, and chromate preparation. Chromium exists in mainly two states, Cr(III) and Cr(VI), of which the concentration of the latter is of greater concern, as it is very toxic. Maximum permissible level in drinking water is ~0.1 mg/L as per Indian standard specifications as well as Environmental Protection Agency.[7] Chromium generally reaches the water bodies through effluents from industrial waste, such as paints, leather tanning, inks, electroplating and metal finishing.

There are various methods in all where have been employed for the removal of Cr (VI) from an aqueous bodies, such as chemical oxidation and reduction, carbon adsorption, ion exchange, electrolytic treatment, membrane separation, liquid extraction, electro-precipitation, coagulation, flotation, crystallization, ultra filtration, evaporation, and electrodialysis.[8] Hence, there is a need to find other low cost, naturally available adsorbents, so that the toxic metal ions can be easily removed. Activated carbon has been also used as a natural adsorbent for the removal of chromium, but it is readily soluble under extreme pH conditions and also not cost-effective. Other alternative materials such as Neem leaves, papaya seeds, rice husk and banana peel, carbon fly ash, cork waste, bagasse fly ash, groundnut shell, coconut have also been investigated.[3,4,5] These materials are waste products from industries and act as natural adsorbents. Under optimum conditions, they can exhibit up to 99%

removal of chromium. These adsorbents are show high adsorption efficiency, easily available, economic and thus are more effective in the removal of heavy metals. Among all the natural adsorbents the Azadirachta Indica (neem) leaves has high potential to remove the heavy metals from effluent. In India, Azadirachta Indica (neem) is a tree which is commonly seen is all where India, the leaves of this tree is burnt and the burnt carbon can be utilized for the treatment and purification of water at a low cost without heavy operation. Cr (VI) has been removed by neem leaves powder (Tawde and Bhalerao, 2010). Some of the study reports the biosorption kinetics and the biosorption equilibrium of Zinc by Neem leaves and stem bark powder (Arshad, *et al* 2008). Neem bark powder (NBP) has been used as an adsorbent for the removal of hexavalent chromium from aqueous solutions (Saravanakumar and Phanikumar 2012). The potentiality of Neem has also been widely studied by different researchers for solving most of the problems related to agriculture, environmental pollution public health, population control (Arshad, *et al* 2008). Hence in this present study, the Azadirachta indica (Neem) leaf powder is studied for his adsorptive capacity to remove chromium (VI) from aqueous solution.

Properties of Neem leaves [8]:
Proteins 7.1% Fat t 1.0%, Fiber 6.2%,Carbohydrates 22.9%, Minerals 3.4%,Calcium 510 mg/100 g, Phosphorous 80mg/100g, Iron 17 mg/100 g, Thiamine 0.04 mg/100 g, Niacin 1.40 mg/100 g, Vitamin C 218 mg/100 g, Carotene1998 microgram, Calorific value 1290 Kcal/Kg/100 g, Glutamic acid 73.30 mg/100 g, Tyrosine 31.50 mg/100g Acid, Aspartic acid 15.50 mg/100 g, Alanine 6.40 mg/100 g Proline 4.00 mg/100 g, Glutamine 1.00mg/100 g.

Adsorption:
The term 'Adsorption' was first used in 1881 by German physicist Heinrich Kayser .Adsorption is a surface phenomenon in which liquid or gaseous molecules adhere to the surface of the solid material. Adsorption is mainly divided into three-physical, chemical and biological phase. Adsorption is mainly described through as isotherms namely, Linear, Freundlich, Langmuir, BET isotherms. Adsorbent is defined as the solid material which adsorbs other materials on its surface. Adsorbate is the substance which is adsorbed. Neem leaf is the adsorbent used here for the removal of chromium Cr (vi). Physical adsorption is based on the Vander Waals forces between adsorbent and adsorbate. Chemical adsorption is due to strong chemical bonding with the molecules. Factors affecting adsorption are adsorbent surface area, adsorbent dosage, adsorbent particle size, contact time temperature, pH and their interactions.

About The Study:
The aim of the present study was to examine the feasibility of using low cost natural absorbents such as neem leave as adsorbent in Chromium Cr (VI) removal using adsorption technique. Adsorption characterization was done by using spectrophotometer. The effect of adsorbent dosage, contact time, pH, initial chromium concentration and shaking speed were determined.

Experimental Investigations:

Materials & Methods:

Preparation of the Adsorbent:
The Neem leaves are collected from the local areas. The leaves collected and dried at low temperature (<105˚C) for 48 hrs to remove moisture content. After drying process, neem leaves were ground to fine powder and sieved through 600 µ size. The adsorbents used in the present research work prepared under nominal treatment only.

Neem Leaf powder

Batch adsorption studies:
A stock solution containing 1000 mL/L of Cr (VI) was prepared using potassium dichromate (K2Cr2O7) in distilled water. All the chemicals used were of analytical grade. The experiments were carried out in 250 mL flasks with a desired amount of adsorbent and Cr (VI) solution. These flasks were then agitated on a shaker at a fixed rpm agitation speed allowing time for equilibrium to be

attained. The concentration of chromium was then determined using an ultraviolet visible spectrophotometer at 540 nm. The batch adsorption studies were carried out by varying the experimental conditions such as adsorbent dosage, contact time, initial chromium concentration, and pH. The percentage of chromium removal was then calculated.[11]

Results and Discussion:

Effect of adsorbent dosage:

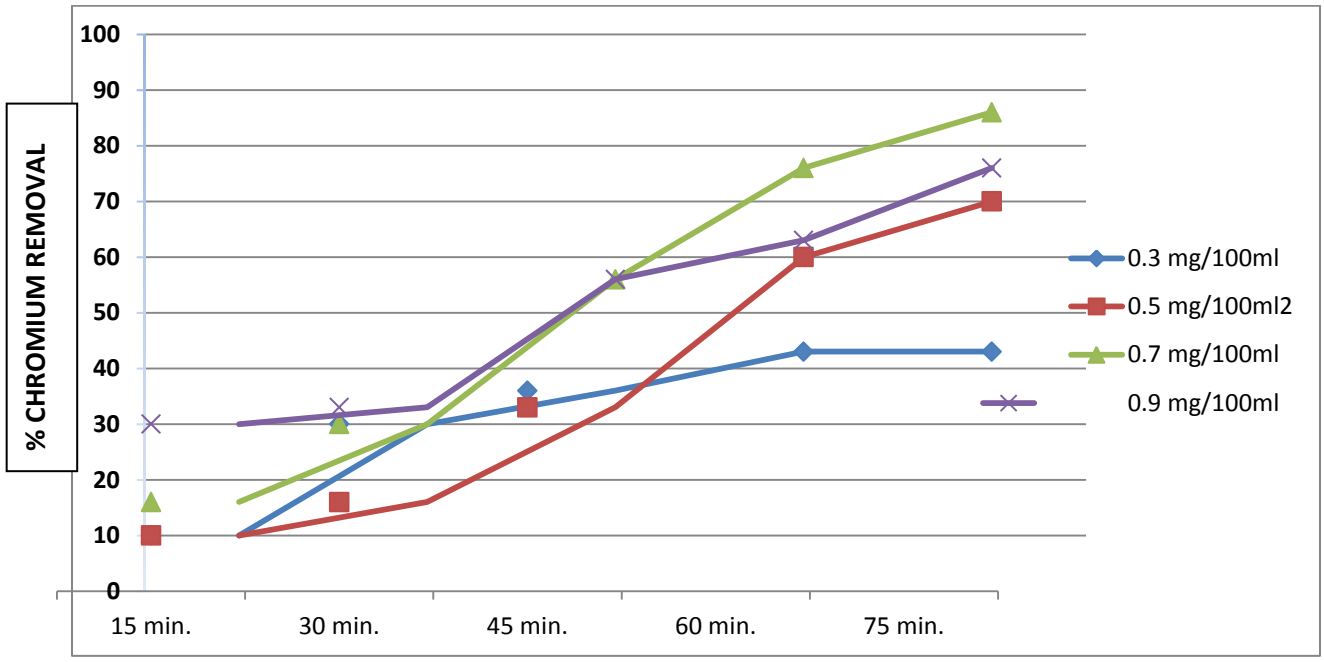
Dosage is so important factor in the adsorption. With the increase in the dosage rate there will be increase in adsorption capacity. It also depends on the saturation limit of the adsorbent. This helps us to get an idea about the amount of adsorbed doses even with the smallest amount, which will be economical. The effect of the adsorbent dose on the removal of chromium was studied by varying the dose from 0.3g/100ml to 0.9g/100ml. The results are presented, where it can be seen that maximum removal of about 86% is found at an adsorbent dose of 0.7 g/100ml and thereafter the percent removal became more or less constant.

Dose(g/100ml)	Contact time (min)	Initial chromium (mg/l)	Final chromium(mg/l)	Reduction in chromium (mg/l)	% removal efficiency
0.3	15	3	2.7	0.3	10
0.3	30	3	2.1	0.9	30
0.3	45	3	1.9	1.1	36
0.3	60	3	1.7	1.3	43
0.3	75	3	1.7	1.3	43

Dose(g/100ml)	Contact time (min)	Initial chromium (mg/l)	Final chromium(mg/l)	Reduction in chromium (mg/l)	% removal efficiency
0.5	15	3	2.7	0.3	10
0.5	30	3	2.5	0.5	16
0.5	45	3	2.0	1.0	33
0.5	60	3	1.2	1.8	60
0.5	75	3	0.9	2.1	70

Dose(g/100ml)	Contact time (min)	Initial chromium (mg/l)	Final chromium(mg/l)	Reduction in chromium (mg/l)	% removal efficiency
0.7	15	3	2.5	0.5	16
0.7	30	3	2.1	0.9	30
0.7	45	3	1.3	1.7	56
0.7	60	3	0.7	2.3	76
0.7	75	3	0.4	2.6	86

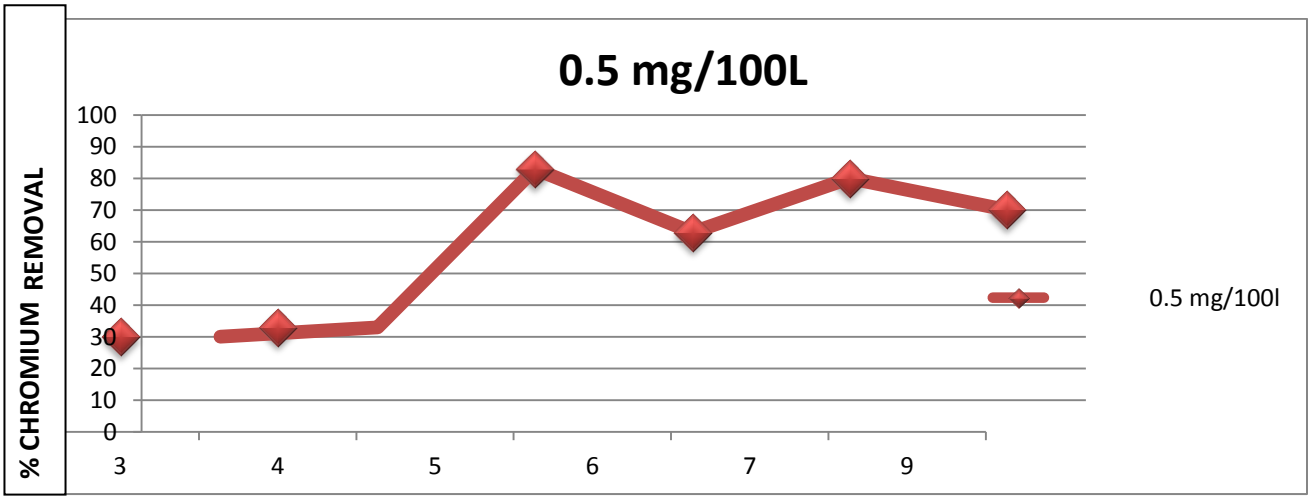
Dose(g/100ml)	Contact time (min)	Initial chromium (mg/l)	Final chromium(mg/l)	Reduction in chromium (mg/l)	% removal efficiency
0.9	15	3	2.1	0.9	30
0.9	30	3	2.0	1.0	33
0.9	45	3	1.3	1.7	56
0.9	60	3	1.1	1.9	63
0.9	75	3	0.7	2.3	76



Effect of pH:

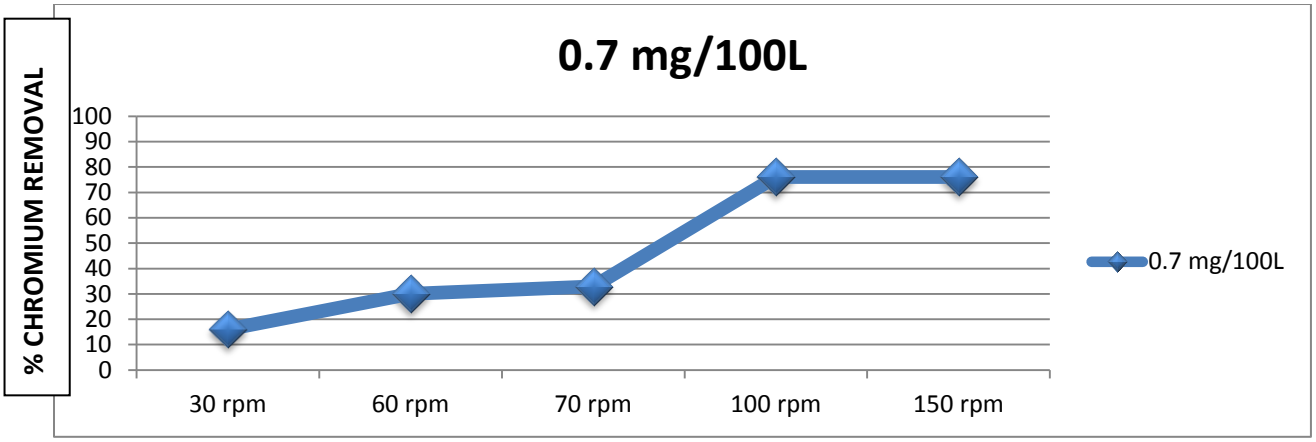
The effect of the pH on the removal of chromium was studied by varying the pH from pH 3 to 9. The results are presented, where it can be seen that maximum removal of about 83% is found at a dose of 5 g/L at 5pH of sample and thereafter the percent removal became more or less constant.

Dose(g/100ml)	pH	Initial chromium (mg/l)	Final chromium(mg/l)	Reduction in chromium (mg/l)	% removal efficiency
0.5	3	3	2.1	0.9	30
0.5	4	3	2.0	1.0	33
0.5	5	3	0.5	2.5	83
0.5	6	3	1.1	1.9	63
0.5	7	3	0.9	2.4	80
0.5	9	3	0.9	2.1	70



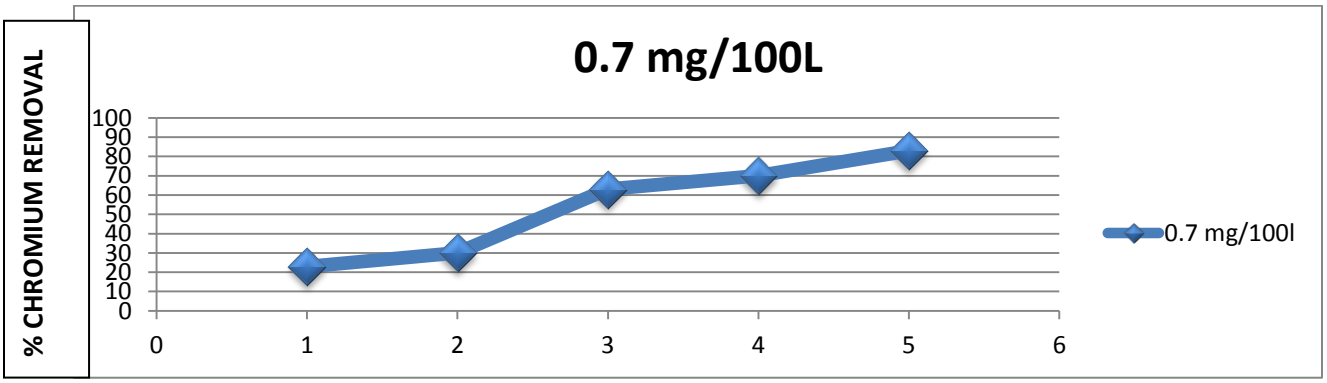
Effect of Stirring rate:
The effect of the stirring rate on the removal of chromium was studied by varying the stirring rate from 50 to 150 rpm. The results are presented, where it can be seen that maximum removal of about 76% is found at a stirring rate of 100 rpm and thereafter the percent removal became more or less constant.

Dose(g/100ml)	Stirring rate (rpm)	Initial chromium (mg/l)	Final chromium(mg/l)	Reduction in chromium (mg/l)	% removal efficiency
0.7	50	3	2.5	0.5	16
0.7	60	3	2.1	0.9	30
0.7	70	3	2.0	1.0	33
0.7	100	3	0.7	2.3	76
0.7	150	3	0.7	2.3	76



Effect of Temperature:
The effect of the temperature on the removal of chromium was studied by varying the temperature from 283 to 313 K. The results are presented, where it can be seen that maximum removal of about 83% is found at a dose of 0.5 g/L at a temperature of 323K and thereafter the percent removal became more or less constant.

Dose(g/100ml)	Temperature (in K)	Initial chromium (mg/l)	Final chromium(mg/l)	Reduction in chromium (mg/l)	% removal efficiency
0.5	283	3	2.3	0.7	23
0.5	293	3	2.1	0.9	30
0.5	303	3	1.1	1.9	63
0.5	313	3	0.9	2.1	70
0.5	323	3	0.5	2.5	83



Conclusion :

From this study, it can be concluded that neem leaves are a very effective adsorbent for the removal of Cr (VI) ions from given water sample. It gave a maximum adsorption at contact time of 75 minutes and adsorbent dosage of 0.7 g/L. The maximum percentage removal of Cr(VI) was found to be 86%. The pseudo-second-order kinetic adsorption model was applicable. It was also observed that the adsorption was pH dependent with maximum adsorption achieved at pH 5.0 with 86% efficiency.

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