National Journal of Advanced Research
ISSN: 2455-216X; Impact Factor: RJIF 5.12
Received: 04-04-2020; Accepted: 20-04-2020; Published: 06-05-2020
www.allnationaljournal.com
Volume 6; Issue 2; 2020; Page No. 08-16

Production and experimental efficiency of activated carbon using the fruit shell of Gulmohar

Chandgude Shubham[1], Deshmukh Pratik[2], Hrutvikraj Mandekar[3], Bhosure Tejas[4]
[1-4] YB Patil Polytechnic Akurdi, Maharashtra, India

Abstract
Water of high quality is essential for human existence and agricultural, industrial, domestic and commercial use and all these activities are also responsible for polluting the water. This is also helpful for the betterment of rural life. Majority of the industries are water based and a considerable volume of wastewater originated from these is generally discharged into water sources either untreated or inadequately treated resulting in water pollution & nbsp; A study conducted by the Centre for Science and Environment, New Delhi, India, has suggested that over 70% of available water in India is polluted (C.S.E. Survey,1982).The contamination of water due to toxic heavy metals through the discharge of industrial wastewater is a global environmental problem.
The heavy metals reach the water bodies through many industrial activities. From the heavy metals chromium is such metal which is to be found in aqueous system as both ionic forms i.e. Trivalent and Hexavalent chromium.
Recently much importance has been given on removal techniques and developments of new process for heavy removal from waste water. There are large number of industries which discharge chromium containing waste, namely tanning, electroplating, textile cement and asbestos, refractories, cooling towers of thermal power stations and many other industries.
Adsorption has been advocated as most promising among the currently known methods for waste water treatment, especially for removal of heavy metals. The adsorption process can be carried out using abundantly available low cost adsorbent.
In the present study Delonix regia pods (Gulmohar) are & nbsp; selected for preparation of activated carbon for removal of Cr (VI) from waste water.

Keywords: water, production, gulmohar, human

1. Introduction
Water of high quality is essential for human existence and agricultural, industrial, domestic and commercial use and all these activities are also responsible for polluting the water. Majority of the industries are water based and a considerable volume of wastewater originated from these is generally discharged into water sources either untreated or inadequately treated resulting in water pollution. A study conducted by the Centre for Science and Environment, New Delhi, India, has suggested that over 70% of available water in India is polluted (C.S.E. Survey, 1982). The contamination of water due to toxic heavy metals through the discharge of industrial wastewater is a global environmental problem.
The heavy metals reach the water bodies through many industrial activities. From the heavy metals chromium is such metal which is to be found in aqueous system as both ionic forms i.e. Trivalent and Hexavalent chromium.
Recently much importance has been given on removal techniques and developments of new process for heavy removal from waste water. There are large number of industries which discharge chromium containing waste, namely tanning, electroplating, textile cement and asbestos, refractories, cooling towers of thermal power stations and many other industries.
Adsorption has been advocated as most promising among the currently known methods for waste water treatment, especially for removal of heavy metals. The adsorption process can be carried out using abundantly available low-cost adsorbent.
In the present study Delonix regia pods (Gulmohar)are selected for preparation of activated carbon for removal of Cr (VI) from waste water.

1.2 Need of study
Currently, environmental pollution has become one of the most important issues faced by human being. It has increased more rapidly in the past few years and reached to alarming levels in terms of its toxic effects on living beings. Although pollution due to tanneries in India dates back to 100 years, it received much attention only in the recent past. Toxic heavy metals are considered as one of the strong pollutants that have direct effect on humans and animals. Industrial wastewater containing lead, copper, cadmium, chromium etc. can contaminate groundwater resources and thus lead to serious ground water pollution problems.
Cr (VI) compounds are strong oxidizing agents and are highly corrosive. Strong exposure of Cr (VI) causes cancer in digestive system and may cause epigastric pain, nausea, and vomiting, severe diarrhoea. Thus, it is required to study the removal of Cr (VI) from wastewater to avoid the hazardous effect.

1.3 Objectives of the research
1. To arrive at the low-cost adsorbent for removal of heavy metal i.e. hexavalent chromium.
2. To study the physical and chemical properties of the prepared activated carbon.
3. 3.To determine the efficiency of the prepared activated carbon.
4. Economical way to remove heavy metals from industrial waste water.

1.4 Scope
1. 1.Seeds of Gulmohar(Royal Poinancios) can also be used for chemically activation to prepare chemically activated carbon.
2. Experiment can also be conducted with adsorbent of different particle size so as to choose the best sized adsorbent.
3. 3.Pilot plant study may be tried using adsorbent.
4. 4.Detailed study may be carried out for disposal of used adsorbent.
5. Experiment may also be conducted to know the effect of initial concentration various Cr(VI).
6. Seeds of Gulmohar(Royal Poinancios) can also be used to remove other toxic metals like lead, cadmium and nickel etc.
7. Experiment may also be conducted to get activated carbon by varying the temperature for finding the removal efficiency of adsorbent.
8. Experiment may also be conducted by varying the temperature of the solutions.

2. Literature Survey
2.1 Introduction
The literatures on various methods developed for removal of heavy metals from waste water are large in number. This chapter deals with literature review on the removal of chromium by adsorption method. Few of the recent works in this field of study are reviewed below.

2.2 Literature Review
2.2.1. Attimodde Girirajanna Devi Prasad and Mohammed Abdulsalam Abdullah

the biosorption of Cr (VI) from synthetic solutions and electroplating waste water using the fruit shell of gulmohar has been investigated in a batch system. The effects of various parameters such as pH, contact time, adsorbent dosage, and initial concentration of Cr (VI) on the biosorption process where studied. The sorption equilibrium exhibited a better fit to the Langmuir isotherm than the freundlich isotherm. The maximum biosorption capacity of fruit shell of gulmohar to remove Cr (VI).

2.2.2. Awoyale, Eloka-Eboka, A.C. and Odubiyi [2], studied that the bamboo can be carbonized (pyrolyzed) at temperatures between 300oC - 400oC and activated using ZnCl2 at 800oC to produce granulated activated charcoal. Adsorption of heavy metals from the refinery waste stream on the activated carbon produced was examined at ambient temperature and, the influence of different operating conditions: contact time, carbon dosages and pH, metal ion concentration before and after adsorption on the adsorbent were used in determining the amount absorbed and the removal efficiency (R%) of the metal ions.Thus the effective observation on using activated carbon produced from local bamboo for the adsorption process was quite efficient and could be employed for other adsorption purposes.

2.2.3. Shashikant.R.Mise, Sugunashree. S.M [3] studied removal of chromium by activated carbon derived from mangiferaindica. The removal of chromium (VI) from synthetic sample by adsorption on activated carbon prepared from MangiferaIndica (mango) seed shell have been carried out at room temperature. The removal of chromium (VI) from synthetic sample by adsorption on chemical activation (Zinc chloride). It is observed that as dosage increases the adsorption increased along with the increase in Impregnation ratio. It was also noted that as I.R. increases the surface area of MangiferaIndica shell carbon increased.

2.2.4. Khairiraihanna Johari, NorasikinSaman, Shiow Tien Song, CheuSiewChin, Helen Kong, Hanapi Mat [4] studiedAdsorption enhancement of elemental mercury by various surface modified coconut husk as eco-friendly low-cost adsorbents.Coconut husk (CH), consisting of coconut pith (CP) and coconut fiber is abundant and cheap, and has the potential to be used as adsorbent for elemental mercury (Hg0) removal. CP and CF surfaces weremodified by mercerization and bleaching methods and characterized using scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR) and analysis of moisture and ash.Thesurface morphology and surface functional groups of adsorbents significantly changed after treatments and resulted in different Hg0 adsorption performances. The experimental breakthrough data for all the adsorbents produced a good fit to the pseudo-second order kinetic model.

2.2.5. Adhena Ayaliew Werkneh, Nigus Gabbiye Habtu, Hayelom Dargo Beyene [5] studied Removal of hexavalent chromium from tannery wastewater using activated carbon primed from sugarcane bagasse Adsorption studies. The removal and recovery of chromium from tannery wastewaters is crucial for environmental protection and economic reasons. Thus, this work focuses on investigating low cost activated sugar cane bagasse for effective removal of hexavalent chrome from aqueous solutions. The b0agasse was collected from different sites of Gondar town, Ethiopia by plastic bags. To increase surface porosity, sugar cane bagasse was pretreated with sulfuric acid. The adsorbent was characterized by FT-IR spectrometry and Sear method for its surface chemistry and BET surface area respectively. The effect of initial concentration, adsorbent dose, pH, contact time and temperature on the batch adsorption/desorption process were examined.this study demonstrates that acid treated bagasse is an effective and cheap adsorbent for the removal of Cr(VI) from aqueous solutions of leather industrial wastes.

2.2.6. Dr. U. Senthilnathan [6] has conducted experiment to test the adsorption kinetics on removal of chromium from wastewater using acacia nilotica wood based activated carbon.Adsorption Capacity for the elimination of Chromium from the waste water has been studied from wood of Acacia Niloticabased activated carbon through various batch adsorption experiments. The adsorption kinetics of chromium using wood of Acacia Niloticawas done by differing factors such as amount of carbon added, pH and concentration levels of Chromium in wastewater. It was observed that the optimum dosage of wood of Acacia Niloticabased activated carbon to remove 80 mg/L of chromium from aqueous solution was 0.4gms/150 mL, and the optimum contact time was 20 minutes. The isotherm data was found to be fit with both Langmuir and Freundlich isotherms.

2.2.7. François Eba1, Raphinos Kouya Biboutou1, Joseph Ndong Nlo1, Yvon G. Bibalou1 and Michel Oyo [7] studied Lead removal in aqueous solution by activated carbons prepared from Cola edulisshell (Alocacée), Pentaclethramacrophylla husk (Mimosaceae).

2.2.8. Aucoumeaklaineanasawdust[8] (Burseraceae). Three activated carbons prepared from vegetable matters of Gabonese biomass are being investigated as adsorbents for the removal of Pb (II) ions from aqueous solutions by means of batch technique. The equilibrium adsorption level was determined to be a function of pH, contact time, temperature and adsorbent dosage. The experimental adsorption data are well applicable to both Freundlich andLangmuir models with the correlation coefficients higher than 0.9. The adsorption process followed thepseudo second order kinetics (R2>0. 9).

2.2.9. Renuga Devi N, Manjusha.K and Lalitha P [9] studied removal of Hexavalent Chromium from aqueous solution using an eco-friendly activated carbon adsorbent, was tested for its ability to remove toxic hexavalent chromium from aqueous solution. The present study is focused on removal of hexavalent chromium from aqueous solution using aeco-friendly adsorbent, activated carbon prepared from the pods of Delonixregia. The effect of optimum dosage, pH and initial concentration of adsorbate on the effective removal of hexavalent chromium has been studied. The results of the study show the adsorption of Cr(VI) to be concentration and pH dependent. The maximum removal of Cr(VI) was observed at pH 2.Removal of Cr(VI) increased from 70.58% to ~100% with increasing adsorbent dosage from 50 to 200 mg. The adsorption process was found to obey Langmuir adsorption isotherm and Freundlich adsorption isotherm. Hence the use of the low-cost carbon prepared is of practical importance and is expected to be economical.

2.2.10. P. Venkateswarlu, M. VenkataRatnam, D. Subba Rao, M. Venkateswara Rao [10]**,** studied Removal of chromium from an aqueous solution using Azadirachtaindica(neem) leaf powder as an adsorbent. Azadirachtaindica(neem) leaf powder is 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 agitation time, adsorbent size and dosage, initial chromium concentration, volume of aqueous solution and pH of the aqueous solution. Adsorption behavior is found to follow Freundlich and Langmuir isotherms. The adsorption mechanism is described by a pseudo second order kinetics.The result shows that leaves of Azadirachtaindica could be used as an alternative, economical and effective material to remove high amount of Cr (VI) ion from waste water.

3. Materials and Methods

3.1. Selection of Material

To evaluate a feasible and economical low-cost treatment. To remove the heavy metal Cr (VI) present in synthetic sample by using abundant available seeds of Gulmohar. By preparing activated carbon from this Gulmohar seeds (Delonix regia) as an adsorbent.

3.2. Properties of Gulmohar (Delonix regia):

3.2.1. Botanical classification:

Table 1: Botanical classification of *Delonix regia*

Common name	Gulmohur
Kingdom:	Plantae
Division:	Phanerogams
Class:	Dicotyledoneae
Subclass:	Polypetalae
Series:	Calyciflorae
Order:	Rosales
Family:	Leguminosae
Sub-family:	Caesalpineaceae
Genus:	Delonix
Species:	Regia

3.2.2. Botanical name: Delonix regia

3.2.3. Synonyms

Delonix regia var. flavida Stehle
Delonix regia var. genuine Stehle
Delonixregia var. genuine Stehlé
Poinciana regia Hook.
Poinciana regia Bojer

3.2.4. Common names

Hindi: Waykaran, Samrsro, Sandeshra
Sanskrit: Siddheshwara
English: Peacock flower, Pride of Barbados
Telgu: Chinnaserribeseri, Chittikeshwaramu
Temil: Perungondrai, Wadanarayanan
Malayalam: Kempukengiga, Niraangi
Marathi: Sankasura, Sanchaila

3.2.5. Botanical Description

The flowers of Delonix regia are large, with four spreading scarlet or orange-red petals up to 8 cm long, and a fifth upright petal called the standard, which is slightly larger and spotted with yellow and white. They appear in corymbs along and at the ends of branches. The naturally occurring variety) has yellow flowers. The pods are green and flaccid when young and turn dark-brown and woody. They can be up to 60 cm long and 5 cm wide. The seeds are small, weighing around 0.4 g on average. The compound leaves have a feathery appearance and are a characteristic light, bright green and are doubly pinnate. Each leaf is 30–50 cm long with 20 to 40 pairs of primary leaflets or pinnae, each divided into 10–20 pairs of secondary leaflets or pinnules. All the description characteristics of this plant are listed in table 3.2.5.

Table 2: Botanical Description of *Delonix regia*

Plant type		Medium- sized, evergreen, perennial and deciduous trees (fig no.3.2.7.1) Height – 35-40 ft
Growing requirements		Soil tolerance: - clay; loam; sandy; slightly alkaline; acidic; well – drained.
(a)	Leaf	have a feathery appearance and are a characteristic light, bright green and are doubly pinnate each leaf is 30–50 cm long
(b)	Flower	scarlet or orange-red petals up to 8 cm long
(c)	Pods	They can be up to 60 cm long and 5 cm wide
(d)	Seed	are small, weighing around 0.4 g on average

3.2.6. Characteristics of Gulmohar

Gulmohar is a flamboyant tree in flower - some say the world's most colorful tree. For several weeks in spring and summer it is covered with exuberant clusters of flame-red flowers, 4-5 in across. Even up close the individual flowers are striking: they have four spoon shaped spreading scarlet or orange-red petals about 3 in long, and one upright slightly larger petal (the standard) which is marked with yellow and white. The delicate, fern-like leaves are composed of small individual leaflets, which fold up at the onset of dusk. Gulmohar gets 30-40 ft tall, but its elegant wide-spreading umbrella-like canopy can be wider than its height.

3.2.7. Figures of *Delonix regia*


Fig 1: *Denolix regia* flower Fig. 3.2.7.2: *Denolix regia* Pods

3.3. Methods of Preparation of activated carbon

For removal of hexavalent chromium from aqueous solution adsorption technique was employed using activated carbon prepared from locally available Seeds of Gulmohar (Royal Poinancios).

There are two methods to prepare activated carbon namely:

1. Physical Activation
2. Chemical Activation

In the present study both physical and chemical activation are employed to prepare active carbon powdered Seeds of Gulmohar (Royal Poinancios).

3.3.1 Physical Activation

The Seeds of Gulmohar (Royal Poinancios), broken into pieces, and churned into powder form, washed in distilled water for 2 to 3 time. The powder was then oven dried at 105±5ºC for 24 hours. The oven dried powder was filled in a small container in three layers, by compacting each layer without any air space to avoid the loss in weight of the powder otherwise it would result in burning of the material directly, leaving behind only the ash. The small container was then placed into a bigger container, such that, sand surrounded the small container completely. The lid of the bigger container was tightly fitted. Then the set-up was kept in muffle furnace at the temperature of 650ºC. After attaining the required temperature, the furnace was allowed to cool for about 10 hours. Before the container was taken out. The sketch furnished in figure 3.1 below was the set-up of the containers. The activated carbon thus obtained was sieved to 300µ (sieve) size and packed in a polythene cover and stored in dessica

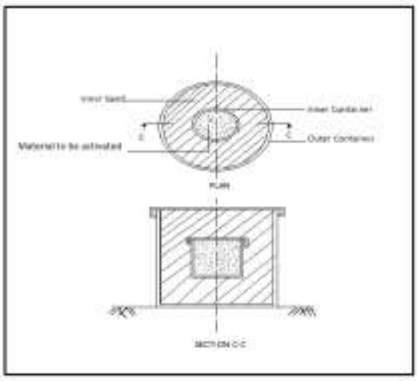

Fig 3: Practical Set Up of the Containers for the Preparation of Activated Carbon

3.4.1 Moisture Content

About 1 gm. of the material was weighed into a petri dish. The dish was placed in an electric oven maintained at 100±5ºC for about 4 hours. The dish was covered, cooled in a desiccator. Heating, cooling and weighing was repeated at 30 minutes intervals until the difference between the two consecutive weighing was less than 5 mg. Data's are shown in table No- 3.1

Moisture Content = 100 (M – X)/ M

(Percent by mass)

Where,

M = Mass in grams of the material taken for the test.

X = Mass in Grams of the material after drying.

Table 1: Moisture Content of Activated Carbon

Types of Carbon	M(g) Mass before drying	X(g) Mass after drying	Moisture Content
1. Physically activated	1.0	0.962	3.80

3.4.2 Ash Content

One gram of the carbon variety under examination was weighed accurately into a tarred porcelain crucible. The crucible and its contents were placed in an electric oven at 110±5ºC for about 4 hours. The crucible was removed from the oven and the content were ignited in an electric muffle furnace at a temperature of 1000ºC for about 3 hours. The process of heating and cooling was repeated until the difference between two consecutive weighing wasless than 1 mg.The ash content of the different carbons are shown in the table – 3.2.

M1

The content (on dry weight basis) = --------------- × 100

M/100 (100-x)

10,000 M1

= ------------------------

M (100 – x)

Where,

M1 = Mass of the ash in grams.

M = Mass of the material taken for the tests in grams.

X = Percentage of moisture content in the material taken.

Table 2: Ash Content of Activated Carbon

Types of carbon	M1 (g) Mass of ash content	M (g) Mass of material taken	X Moisture content (%)	% Ash
1. Physically activated	0.196	1.00	3.80	19.70

3.4.3 Decolourising Power
About 0.1 g of the carbon material was transferred to 50 ml glass stoppered flask. 1 ml of methylene blue solution (0.15%) was added from a burette and shaken for 5 min. Addition of methylene blue solution and shaking was continued till the blue color persisted for at least 5 minutes.
Decolourising power of carbon is expressed in terms of milligram of methylene blue adsorbed by 1 g of activated carbon.
Decolourising power (mg/g) = 1.5^{*} V/M
Where, V = Volume in ml of methylene blue solution consumed.
M = Mass of the material taken for the test in grams.
The decolourising power of different carbons are shown in table – 3.3

3.4.4pHValues Of Prepared Activated Carbons
10 g of the dried material was weighed and transferred into a one litre beaker. 300 ml of freshly boiled and cooled distilled water (adjusted to pH7.0) was added and heated to boiling. After digesting for 10 min, the solution was filtered while hot, rejecting the first 20 ml of the filtrate, the remaining filtrate was cooled to room temperature and pH was determined using digital pH meter.
The P^{H} values of different carbons are shown in table 3.4

Table 3: pH Value of Prepared Activated Carbon

Type of Carbon	pH Value
1. Physically activated	09.09

3.4.5 Determinations of Surface Area (Acetic Acid Adsorption Method)
I Gram of carbon was accurately weighed to the nearest milligram and added to a series of 300 ml stoppered glass bottles. Acetic acid solutions in the range of 0.015 M to 0.15 M were prepared separately and 100 ml of these solutions were added. The another bottle 100 ml of 0.03 M acid alone was added which is in absence of carbon served as a control. The flasks were tightly stoppered and then shaken in a rotary mechanical shaker.
At the end of equilibrium period the samples were filtered through fine filter paper. The first 10 ml of the filtrate was rejected, from the remaining filtrate. 25 ml aliquots were withdrawn and filtrated against 0.1 N standard sodium hydroxide solution using phenol phenolphthalein indicator.
The final concentrations of acetic acid were calculated for each sample. By noting the difference in initial and final concentration of acetic acid, the number of moles of acetic acid adsorbed by the carbon was calculated. The number of moles of acid adsorbed per gram of carbon was then computed which is designated as N.
The concentration of acetic acid remaining in each instants (C) was divided by number of moles of acid adsorbed per gram (N) of the carbon to get the ratio C/N. A plot of C/N versus the concentration of acetic acid remaining in the containers after adsorption process (C) was made. A straight-line plot was obtained. The reciprocal of the slope of the straight line gives the Number of moles of acetic acid required per gram to form a monolayer which is designated as (Nm). By assuming that the molecular cross-sectional area of acetic acid as 21 area available in square metre per gram of the carbon calculated from the following equation.

3.4.6 Determination of Specific Gravity
The specific gravity of the prepared carbon was determined using pyconometer as follows by determining
1. Empty weight of pyconometrer W1
2. Weight of pyconometer + distilled water W2
3. Weight of pyconometer + 1/3 carbon W3
4. Weight of pyconometer + 1/3 carbon + distilled water W4

W3 – W1
The specific gravity of the prepared carbon ----------------
(W2 – W1) – (W4 – W3)
The specific gravity of the prepared carbon are shown in Table 3.4

Table 4: Specific Gravity of Prepared Carbon

Types of Carbon	W1	W2	W3	W4	Specific Gravity
1. Physically Activated	23.00	75.57	25.58	74.94	0.803

Table 5: Density of Prepared Carbon

Type of Carbon	Mass m (gm)	Volume V (cc)	Density (gm / cc)
1. Physically Activated	11.00	50.00	0.22

3.5 Instruments
Spectrophotometer
Chemito model UV 2100UV- Visible Spectrophotometer with 10 mm cell path cuvettes was used for all measurements.

pH Meter
Hanna Instruments Model-HI 98107 Pocket pH Tester (digital pH meter accuracy ± 0.1 pH unit with combined electrode) was used for all pH measurements.

3.6 Solutions
3.6.1 Preparations of Synthetic Hexavalent Chromium Solution
Synthetic hexavalent chromium solution was prepared by dissolving 282.8 mg potassium dichromate in one litre of deionised and distilled water,such that each ml of solution contains 100µg of chromium.

3.7 Titration Curve for Acidification of Chromium (VI) Solution
5 ml of chromium solution and 45 ml distilled water were taken in a beaker. 0.1 N H_2SO_4 was taken in burette and slowly added, the resulting P^{H} was noted using P^{H} meter. The titration curve can be obtained by plotting pH versus 0.1 N H_2SO_4 added. The resulting plot is shown in figure 3.2

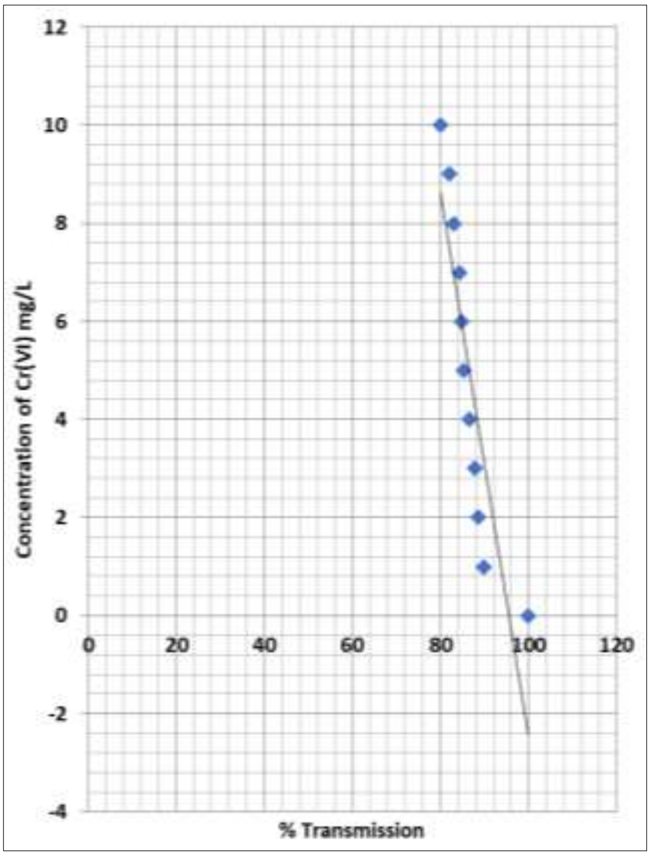

Fig 4: Calibration Curve for Cr (VI)

3.8 Batch Sorption Experiment
In batch sorption, a pre-determined amount of adsorbent is mixed with the sample, stirred using magnetic stirrer for a given contact time and subsequently separated by filtration. Powdered adsorbent is more suitable for the batch type contact process.

3.8.1 Selection of Optimum Contact Time
The adsorption is strongly influenced by the contact time. For study of effect of contact time, 100 ml of 10 mg/L hexavalent chromium solution of $P^{H}2\pm0.02$ was mixed with 100mg of activated carbon, stirred at different contact times. Then filtrate was analyzed for chromium (VI) concentration using spectrophotometer.

3.8.2 Determination of Optimum Dosage Adsorbent
Top determine the optimum dosage of activated carbon; it was added to conical flask in different dosages containing known concentration of chromium (VI) solution (10 mg/ L) and adjusted to p^{H} 2.0. The solution in the conical flask was subjected to stirring for optimum contact time, filtered and analyzed for residual chromium concentration.
The dosage which gives minimum residual concentration is chosen as optimum dosage.

3.8.3 Effect of pH on Hexavalent Chromium Removal
The extent of adsorption is strongly influenced by the pH at which adsorption is carried out. The effect of pH on hexavalent chromium adsorption was studied by performing equilibrium adsorption tests at different pH. Initial pHof solution was adjusted by using 0.1 N H_2SO_4 or 0.1 N NaoH. The pH at which maximum chromium (VI) removal forms optimum pH.

3.9 Sorption Kinetics
The beakers containing 100 ml of hexavalent chromium solutions of concentration 10 mg/L (adjusted to pH 2.0± 0.02) and known amount of optimum prepared activated carbon from Seeds of Gulmohar(Royal Poinancios) were stirred. The samples were withdrawn at different at intervals and filtered supernatant were analysed.

3.10 Sorption Equilibrium
To the beakers containing 100 ml of 10 mg/L chromium (VI) solutions (adjusted to pH 2.0 ± 0.02). Different dozes of prepared carbons were added and stirred for optimum contact time. The filtered supernatant solution was analysed for chromium (VI) concentration.

3.11. Hexavalent Chromium and its negative effects on the environment
- Chromium is used mainly in metal alloys such as metal-ceramics, stainless steel, and is used as chrome plating.
- Chromium has high value in the industrial world because it can be polished to a mirror-like finish, and provides a durable, highly rust resistant coating, for heavy applications.
- On the flip side, chromium can also provide health benefits to humans.

Impacts on Human Health
Chromium VI (hexavalent chromium) is considered carcinogenic (Having the potential to cause cancer) only to animals in certain circumstances at this point; chromium in general is currently not classified as a carcinogen as the OSHA and is fairly unregulated, but is considered toxic, level 3.
Chromium VI is the most dangerous form of chromium and may cause health problems including: allergic reactions, skin rash, nose irritations and nosebleed, ulcers, weakened immune system, genetic material alteration, kidney and liver damage, and may even go as far as death of the individual.

Prevention or Mitigation
There are currently no standards or regulations regarding hazard mitigation. Water purification is completely optional, but active carbon and ion exchanging filtering methods are both very effective in eliminating chromium contamination.

4. Results & Discussion
The chapter deals with the study efficiency of prepared carbon for removing hexavalent chromium for,

a. Effect of contact time
b. Effect of carbon dosage
c. Effect of pH

4.1 Effect of Particles Size on Adsorption
Adsorption is a surface phenomenon; as such the extent of adsorption is proportional to specific surface area. Hence the amount of adsorption per unit weight of solid adsorbent is greater in the more finely divided and more porous material. Rate of adsorption depends mainly on particle size. Finer the particle, higher the rate adsorption and wise-versa. However, there is a limitation for particle size, If particle size is less than 175 µ, Each particle having small surface area, act as an individual entity for the removal of adsorb ate from aqueous solution. Hence in the present study experiments were carried out using effective particle size of

300µ for removal of chromium (VI).

4.2 Effect of Contact Time

Contact time has great influence in the adsorption process. The effect of contact time on the removal of chromium (VI) for synthetic sample at pH 2±0.02 using physically carbon of Seeds of Gulmohar(Royal Poinancios)in figure- 4.1and model values are shown in the table 4.1 from the table it is observed that contact time differs for different carbons i.e. for physically activated carbons. It is further authenticated by studying pore diffusion of carbons. As the time passes, pore diffusion increases, Hence adsorption also increases.

4.3 Effect of Adsorbent Dosage

Adsorption is a process in which there is a continuous transfer of solute from solution to adsorbent until residual concentration of solution maintains an equilibrium with that adsorbed by the surface of adsorbent at constant contact time. Effect of adsorbent dosage is studied and graph of percentage of chromium removal versus dosage is plotted as shown in figure no 4.2. From the graph it is observed that, as the doses of carbon increases, amount of residual chromium (VI) decreases sharply and attains minimum. The point where maximum removal is attained is taken as optimum dosage. After this not much change in adsorption is observed even after increasing the amount of carbon. The optimum dosage for all prepared carbon are listed in table 4.2.

4.4 Effect ofpH On Hexavalent Chromium Removal

The pH of a solution has influence on the extent of adsorption removal efficiency of chromium (VI) by prepared activated carbon at different pH values are shown in table 4.3 and figure 4.3. From the shown figure it is observed that chromium (VI) is removed more effectively in acidic range. As pH increases, the removal efficiency decreases appreciably. This is due to possibility of precipitation of carbon surface by nucleation.

$2H^+ + 2HCrO_4^- \leftrightarrow 2H_2CrO_4 \leftrightarrow 2H_2O + Cr_2O^{-2} + 2H^+ \leftrightarrow 2CrO_3 + H_2O$

The H_2CrO_4 and CrO_3probably exist as polynuclear species, along with their anhydrous from at high chromium concentration and at low pH. Thus, high degree of adsorption of Cr (VI) is due to the ability of chromium to stabilize itself, forming dissociate poly-nuclear species as well as CrO_3 crystallization is proton consuming process and requires constant source of protons. This indicates that crystallization of chromium anhydride is the final form 0f chromium when it is adsorbed on activated carbon. The other mole of chromium adsorption is also due to the formation of more $HCrO_4$ species in aqueous solution of chromium the following equillibria holds good.

$Cr_2O_7^{-2} + H_2O \leftrightarrow 2H_2CrO_4$

$Cr_2O^{-2} + 2H^+ \leftrightarrow Cr_2O_7^{-2}$

$Cr_2O^-_4 + H_2O \leftrightarrow H_2CrO_4 + CH^-_2$

With decreases in pH more $Cr2O7^{-2}$ is formed equation. Which in turn changes to $2H_2CrO_4$ as equation H_2CrO_4..Species adsorbed on the surface of carbon as pH is less $Cr_2O_7^{-2}$ is more, formation HCr^-_4 is more and adsorption is more. Hence we have used optimum pH 2±0.02 for chromium (VI) adsorption.

Table 6: Effect of Contact Time on Removal of Cr (VI) Initial concentration =10.0 mg/L Dosages of Adsorbent =100 mg pH =2±0.02 Temperature=32±1°CVolume of sample=1000 ml

Time in minutes	Cr (VI) Adsorbed on prepared activated carbon (mg/L)	Concentration of Cr (VI) remaining in solution (mg/L)	Removal of Cr (VI) %
03	2.4	7.6	24
05	3.0	7.0	30
07	4.0	6.0	40
10	4.5	5.5	45
13	4.8	5.2	48
15	5.0	5.0	50
20	5.1	4.9	51
25	5.2	4.8	52
30	5.5	4.5	55
35	6.0	4.0	60
40	6.1	3.9	61
45	6.4	3.6	64
50	6.5	3.5	65
55	6.5	3.5	65

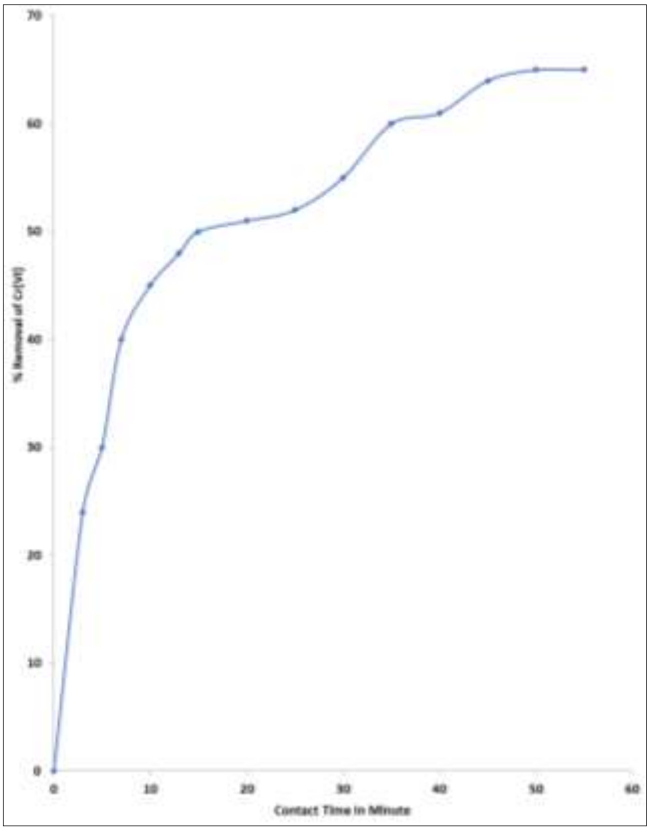

Fig 5: Effect of Contact Time on Cr (VI) Removal

Table 7: Effect of Adsorbent Dosages on Activated Carbon Initial concentration =10.0 mg/L pH =2±0.02 Temperature=32±1° C

Adsorbent dosages in mg	Concentration of Cr (VI) remaining in solution (mg/L)	Cr (VI) Adsorbed on prepared activated carbon(mg/L)	Removal of Cr (VI) in %
20	9.5	0.5	5

40	9.0	1.0	10
60	7.9	2.1	21
80	6.6	4.4	44
100	3.45	6.55	65.5
120	3.5	6.5	65
140	3.5	6.5	65
160	3.5	6.5	65
180	3.5	6.5	65
200	3.5	6.5	65
220	3.5	6.5	65

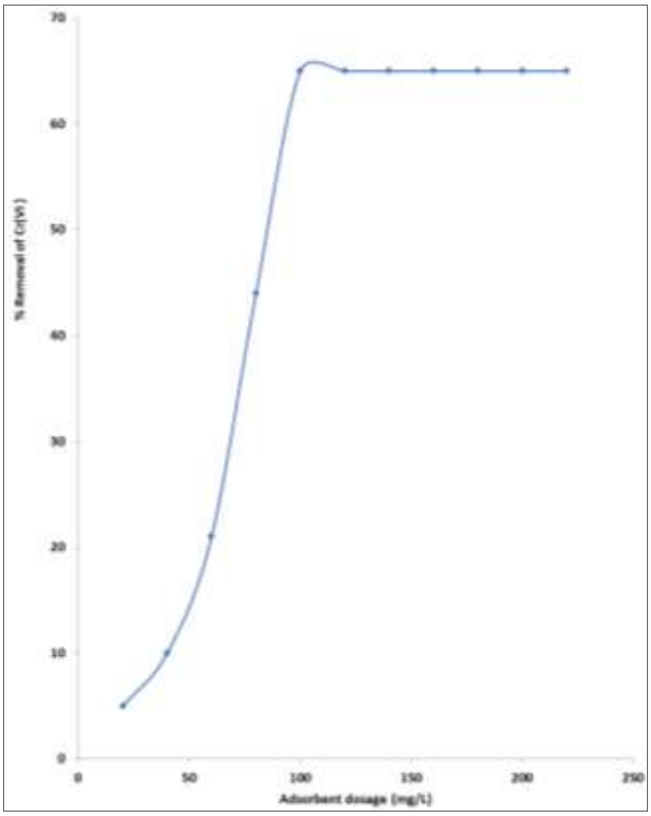

Fig 6: Effect of Adsorbent dosage on Cr (VI) removal by prepared Activated Carbon

Table 8: Effect of pH on Cr (VI) Removal by Prepared Activated Carbon Initial concentration =10.0 mg/L Dosages of Adsorbent =100 mg Temperature=32±1^0 C

pH	Concentration of Cr (VI) remaining in solution (mg/L)	Cr (VI) Adsorbed on prepared activated carbon (mg/L)	Removal of Cr (VI) in %
2.0	3.3	6.7	67
3.0	3.9	6.1	61
4.0	4.6	5.4	54
5.0	5.0	5.0	50
6.0	5.4	4.6	46
7.0	5.9	4.1	41
8.0	6.4	3.6	36
9.0	6.9	3.1	31
10.0	7.2	2.8	28

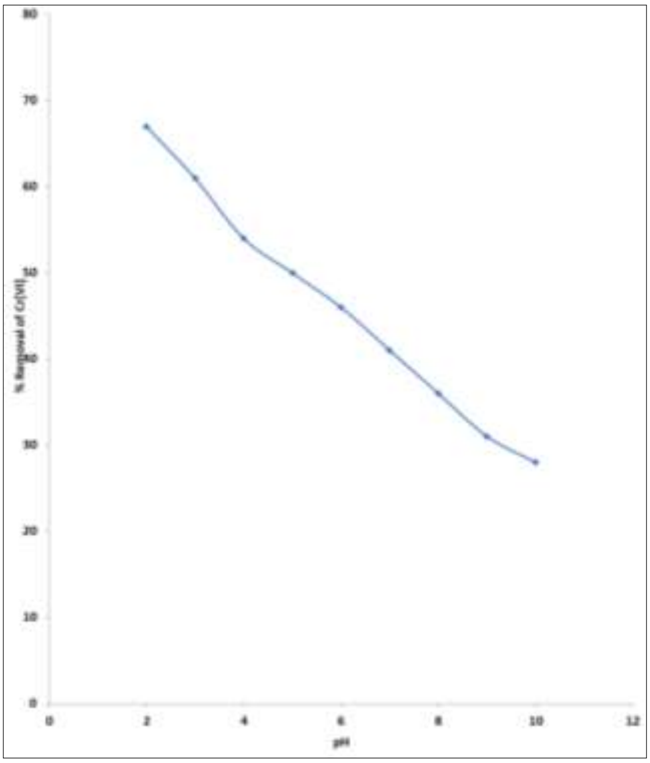

Fig 9: Effect of pH on Cr (VI) Removal by Activated Carbon

Table 9: Optimum Contact Time, Optimum Dosage and, OptimumpH For Prepared Activated Carbon Initial concentration =10.0 mg/LTemperature=32±1^0 C

Type of Carbon	Optimum time in minute	Optimum Dosages in mg	Optimum pH
Activated Carbon	50	120	2.0

5. Conclusions

Based on the present study, the following conclusion can be drawn.

1. Raw material of Seeds of Gulmohar (Royal Poinancios) has low efficiency in Cr (VI) removal.
2. Seeds of Gulmohar (Royal Poinancios) can be effectively used for the preparation of activated carbon.
3. The adsorption of Cr (VI) is pHdependent. The removal efficiency of adsorbent increased with decrease in pH value of solution. Maximum adsorption takes place at pH2.

4. From the kinetic studies it is observed that, adsorption of Cr (VI) is very rapid up to 45 minutes and decreases while approaching equilibrium.
5. At optimum time 50 minutes, optimum dosage of 100 mg and optimum pH =2 physicallyActivated carbon made from Seeds of Gulmohar (Royal Poinancios) has shown good Cr (VI) removal efficiency of 65%.
6. Seeds of Gulmohar (Royal Poinancios) is good source for preparation of low-cost adsorbent.

References

1. Attimodde Girirajanna Devi Prasad And Mohammed Abdulsalam Abdullah, "biosorption of Cr (VI) from synthetic wastewater using the fruit shell of gulmohar (Delonix regia)" bioresource engineering international journal.
2. Awoyale, Eloka-Eboka AC, Odubiyi OA "production and experimental efficiency of activated carbon from local waste bamboo for waste water treatment" international journal of engineering and applied sciences"
3. Shashikant R Mise, Sugunashree SM "removal of chromium (vi) by activated carbon derived from mangifera indica" international journal of research in engineering and technology
4. Khairiraihanna Johari, Norasikin Saman, Shiow Tien Song, Cheu Siew Chin, Helen Kong, Hanapi Ma, *et al*. "Adsorption enhancement of elemental mercury by various surface Modified coconut Husk as eco-friendly low cost adsorbeants.
5. Adhena Ayaliew Werkneh, Nigus Gabbiye Habtu, Hayelom Dargo Beyene "Removal of hexavalent chromium from tannery wastewaterusing activated carbon primed from sugarcane bagasse: Adsorption/desorption studies" American Journal of Applied Chemistry.
6. Dr. U Senthilnathan "adsorption kinetics on removal of chromium from wastewater using acacia nilotica wood based activated carbon" International Journal of Advanced Research
7. François Eba, Raphinos Kouya Biboutou, Joseph Ndong Nlo, Yvon G. Bibalou1 and Michel Oyo "Lead removal in aqueous solution by activated carbons prepared from Cola edulis shell (Alocacée), Pentaclethra macrophylla husk (Mimosaceae) and Aucoumea klaineana sawdust (Burseraceae)" African Journal of Environmental Science and Technology
8. Aucoumeaklaineanasawdust (Burseraceae). Three activated carbons prepared from vegetable matters of Gabonese biomass are being investigated as adsorbents for the removal of Pb (II) ions from aqueous solutions by means of batch technique.
9. Renuga Devi N, Manjusha K, Lalitha P. "Removal of Hexavalent Chromium from aqueous solution using an eco-friendly activated carbon adsorbent" Pelagia Research Library
10. Venkateswarlu P, Venkata Ratnam M, Subba Rao D, Venkateswara Rao M. "Removal of chromium from an aqueous solution using Azadirachta indica (neem) leaf powder as an adsorbent" International Journal of Physical Sciences.