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Investigation &Comparative Study of Effectiveness of Adsorbent Synthesized from '*Tectona grandis*' seed in removal of Cr(VI) from aqueous solution.

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ABSTRACT
Waste disposal is becoming a cause of concern &alot of research is being carried out for removal of pollutants. Adsorption is viewed as one of the effective methods & new adsorbents having low cost, bio-degradability& effectiveness are being developed. Bark, leaves, seeds, drumsticks&shells can be synthesized into adsorbents.Present work addresses to the development of adsorbent from waste materials such as '*Tectona grandis*' seeds. Thermal and boiling water treatment have been adopted in synthesis of three types of adsorbents namely 'Thermally treated whole seed', 'Thermally treated particulateseed' & 'Raw boiled whole seed'. In preliminary investigation 'Raw boiled whole seed' is found to be effective in 12% adsorption of Victoria blue from synthetically prepared aqueous solution. Similarly these adsorbents are useful in removal of Cr(VI) from aqueous solution to the extent of 12 to 52 % depending upon the type of adsorbent and initial feed solution. 'Thermally treated particulate seed' is observed to be the best amongst three adsorbents synthesized. It can concluded that there is need to tap the potential in adsorbentssynthesized from '*Tectona grandis* seed' by conducting more experiments involving different types of adsorbents.
Keywords– Adsorption,Boiled & Thermally treated,Cr(VI), '*Tectona grandis*seed' & Victoriablue.

I. INTRODUCTION

Adsorption has been used as a physico-chemical process over the last decades in which moleculesof the solute get distributed between two phases, one of which is a solid whereas the other may be liquid or gas. In adsorption molecules diffuse through the bulk of fluid to the surface of the solid adsorbent & forma distinct adsorbent phase.Physisorption and Chemisorption are two type of adsorption in which the adsorbateadheres to the surface only through Van der Waals andthroughthe formation of a chemical bond respectively.

The disposal of streams containing hazardous heavy metals into the environment has made the governments to impose stringent standards forwaste management. This has prompted many industries to sponsor special studies on the removal of heavy metals. Chromium ions are amongst the heavy metal ions present in effluent of many chemical process industries.The toxicity of chromium depends on its oxidation state and water quality. Of the tri and hexavalent chromium, Cr (VI) was found to be more toxic and it readily passes through the red blood cell membrane. Main consequences of occupational exposures are the Respiratory effects. Exposure to chromium dust and mists can cause irritation of skin ,respiratory tract, sinus cancer Workers who are exposed to high levels of Cr(VI) from ingestion of potassium dichromate have reported the problem of acute renal failures.

A glance through the literature furnishes information on various locally available resources, agricultural wastes being used to remove the heavy metals from aqueous solutions. Many adsorbents were tested to remove hexavalent chromium from aqueous solutions and wastewater which include study on the adsorption of hexavalent chromium from the aqueous solutions using powder of papaya seeds[1] , Adsorption of Pb (VI) ions on Tamarindous indica seeds[2] & teak tree bark powder [3] for removal of methylene bluefromaqueous solution, Adsorbents synthesis from Waste Materials such as Ziziphus Jujube Seed & Mango Kernel[4],Characterization and adsorption studies of Activated carbon prepared from rice husk, Sugarcanebaggasse and saw dust[5], Adsorbents from karanja seed oil cake[6]& Comparative analysis of the efficiencies of two low cost adsorbents in the removal of Cr(VI) and Ni(II) from aqueous solution [7] are to name few.

The present work [8] is aimed at the utilizationof waste material like *Tectona grandis* (Teak) whole seed by converting into adsorbent and comparative study of boiling water and thermally treated seed for removal of Cr(VI) from aqueous solution..

II. PRESENT WORK

2.1 Objectiveof present work:

The objective of the present work is utilization of agricultural waste material such as '*Tectona grandis'* (teak) whole seeds into useful product such as adsorbent. Thermal and chemical methods of synthesis have been used for this purpose. The work is further extended in removal of colouring agents such as victoria blue and potassium dichromate from aqueous solution.

2.2 Methodology:

Three types of adsorbent are prepared:

1. TTW - 'Thermally treated whole Tectona grandis seed adsorbent'.
2. TTP -'Thermally treatedparticulate*Tectonagrandis*seedadsorbent'.
3. RBW - Raw boiled whole'Tectona grandis' seed adsorbent.

The work is thus divided into three parts :

1. Synthesis of adsorbent using thermal methods using '*Tectona grandis*' whole seeds.
2. Preliminary investigations in evaluation of effectiveness of '*Tectona grandis'* whole seed synthesis in removal of Victoria blue from aqueous solutions.
3. Adsorption studies in removal of Cr(VI) from aqueous solution of potassium dichromate using '*Tectona grandis*' seed as a adsorbent.

2.3 Materials and method

2.3.1 Materials used in present work

- Agriculture waste materials such as '*Tectona grandis*' whole seed.
- Victoria blue.
- Potassium dichromate.
- Distilled water.

2.3.2 Method Present work part 1:

- Synthesis of *'Tectona grandis'* whole seed adsorbent using thermal treatment.
- Experimental procedure adopted in synthesis of adsorbent is given in flow chart as shown in Fig.1
- Photographs of the process steps followed in present work are shown in Fig.2

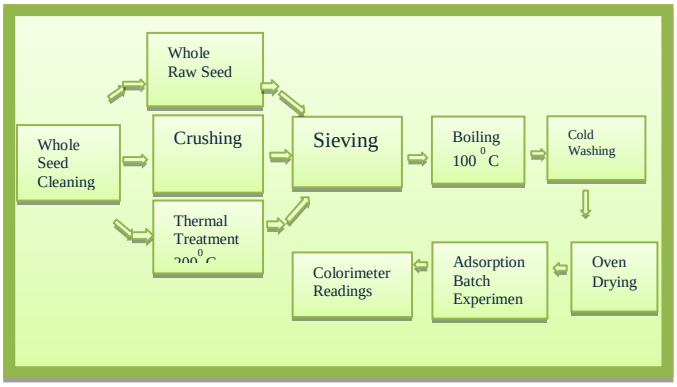

Fig.1: Flowchart of Experimental Procedure.

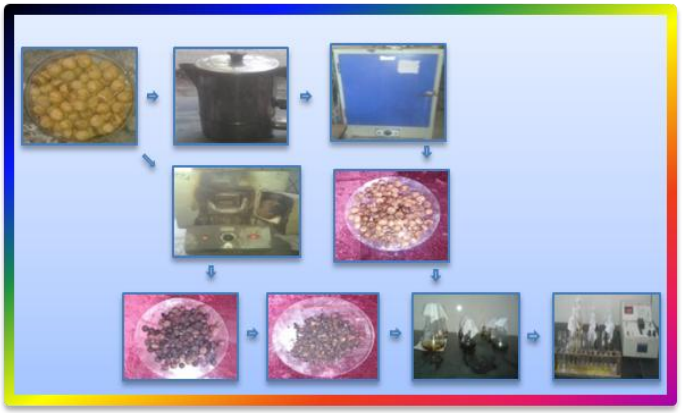

Fig.2:Photographs of Process Steps.

III. OBSERVATIONS:

3.1 Synthesis of adsorbent:

- Procuring, cleaning, washing, sieving of *'Tectona grandis'* whole seeds is carried out.
- Thermal treatment of whole seed at 200 ^{0}C is carried out in a furnace.
- Details of the process parameters followed in synthesis are as shown in Table 2.
- Crushing some of thermally treated whole seed into adsorbent powder.
- Adsorbent synthesized are boiled using 900 cc ofwater for 50 gm of adsorbent.
- The details of washing are given in table 2. This was necessary for removal of natural colour from adsorbent.
- This was followed by cold washing and then Oven drying at 100 ^{0}C.

Table 1: Heating Raw Seed in Furnace.

Sr No	Initial weight (gm)	Final weight (gm)	Temperature of furnace (^{o}C)	Time required (min)
1	25	18	200	18
2	24	16	210	24
3	22	13	230	20
4	20	12	200	20

Table 2 : Thermal treatment of raw seed and its Drying.

Sr No	Material	Time of drying (min)	Time of Residence of material in solution (hr)	Temp. during drying (^oC)	No of washings	Vol. of water for Boiling (ml)
1	TTW	90	45	100	10	4500
2	TTP	70	45	100	6	3000
3	RBW	80	21	100	8	3600

3.2Adsorption Studies:Preliminary investigation & Adsorption studiesinremoval of victoria blue & Cr (VI)from aqueous solution.

- Preparation of stock solutions of Victoria blue &$K_2Cr_2O_7$ in water.
- Calibration of colorimeter is done.Graphs are plotted as shown in Fig. 3 & Fig.4 for solutions of Victoria blue &$K_2Cr_2O_7$ in water respectively.

Preparation of feed solution:

- Diluting the stock solution to three different knownconcentrationsof Victoria blue &$K_2Cr_2O_7$ in water respectively.
- A known weight of adsorbent is added to beakers containing known volume of aqueous solution.
- Contacting of adsorbent &aqueous solution using stirrer/manual shaking.
- Taking colorimeter reading of aqueous solution containing adsorbate at equilibrium.
- Calculating final concentration of adsorbate remained as shown in Table 3 in aqueous solution from standardization graph for adsorption of Victoria blue using RBW as adsorbent.
- The details of adsorption studies in removal of victoria blue using RBW are as shown in Table 3.
- Similarly Table4 gives details of final concentration readings for three different adsorbents in $K_2Cr_2O_7$ solution.
- Table 5 givesthe details of adsorption studies in removal of $K_2Cr_2O_7$ using *'Tectona grandis'* seed as adsorbent.

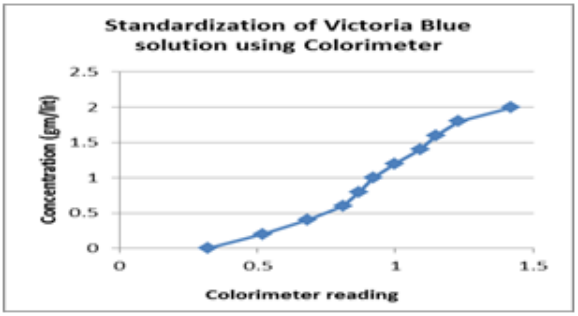

Fig. 3 : Standardization of Victoria Blue solutionusing colorimeter.

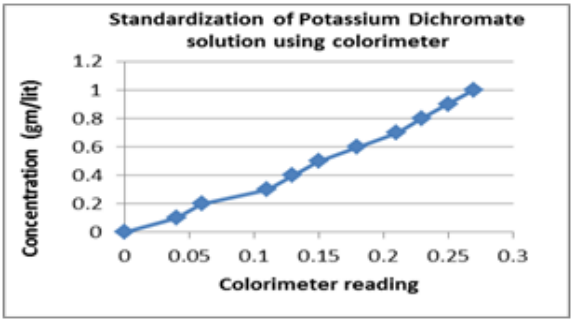

Fig.4 : Standardization of Potassium Dichromate solution using colorimeter.

Table 3: Calculation for adsorption of Victoria blue solution using *'Tectona grandis'* as adsorbent.

Sr No	Factors	Readings
1	Concentration	250
2	Particle Size (cms)	1.05
3	Vol. of Sample (ml)	50
4	Qty of Adsorbent (gm)	5
5	Optical Density	0.53
6	Qty adsorbed (mg)	0.0015
7	Conc. of adsorbate remained	220
8	Qty adsorbed/weight of adsorbent (mg/gm)	0.0003
9	%Adsorption	12

Table 4 Final concentration for $K_2Cr_2O_7$solution.

Adsorbent	Initial conc. (gm/lit)	Colorimeter Readings	Final Conc. (gm/lit)
TTW	1	0.17	0.55
TTP	1	0.15	0.5
RBW	1	0.21	0.7
TTP	0.5	0.11	0.3
TTP	0.5	0.08	0.24
RBW	0.5	0.13	0.4
TTW	0.25	0.07	0.22
TTP	0.25	0.06	0.2
RBW	0.25	0.08	0.24

Table 5 : Calculation of final readings taken for '*Tectona grandis*' as adsorbent in $K_2Cr_2O_7$ solution.

Quantity of Adsorbent – 3 gm

Sr. No	Adsorbent	Conc. (ppm)	Particle Size (cm)	Qty adsorbed (mg)	Conc of adsorbate remained (ppm)	Ratio (Qty adsorbed/ weight of adsorbent) mg/gm	% Adsorption
1	TTW	1000	1.0	0.0225	550	0.0075	45
2	TTP	1000	0.49	0.025	500	0.0083	50
3	RBW	1000	1.21	0.015	700	0.005	30
4	TTW	500	0.92	0.01	300	0.003	40
5	TTP	500	0.59	0.013	240	0.00433	52
6	RBW	500	1.1	0.005	400	0.00166	10
7	TTW	250	0.88	0.0015	220	0.0005	12
8	TTP	250	0.32	0.0025	200	0.000833	20
9	RBW	250	0.99	0.0005	240	0.041	1

IV. RESULT AND DISCUSSION

Various observations are recorded related to the adsorption studies and analysed for interpretation and evaluation of the effectiveness of the adsorbents synthesized. The comparative study is carried out and inference is drawn regarding more suitable method of synthesis.

The criteria of effectiveness of the adsorbent synthesized is based on the % adsorption of Cr(VI)from aqueous solutions . Graphs have been plotted for this purpose between various parameters such as % adsorption verses type of adsorbent, % adsorption verses concentration of feed solution, equilibrium concentration in solid and liquid phases as shown in the figures 5-9.

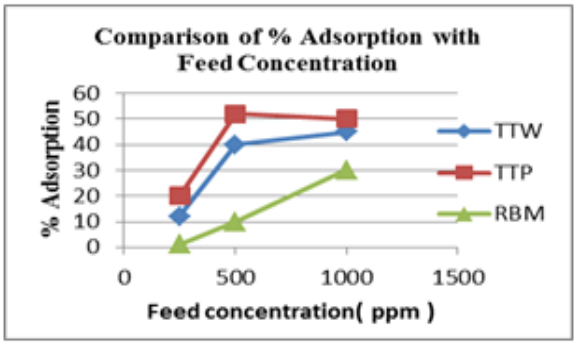

Fig. 5:Comparison of % Adsorption with Feed Concentration of $K_2Cr_2O_7$.

It is seen from the Fig. 5 that % adsorption is maximum with TTP followed by TTW and RBW for the same adsorption parameters like feed concentration, contact time. It can also be inferred that smaller partical size of thermally treated '*Tectona grandis*' crushed seed is more effective than thermally treated whole seed in removal of Cr(VI) from aqueous solution. Thermal treatment observed to be effective in adsorption of Cr (VI) and creating active surface area over the raw boiled whole seed.

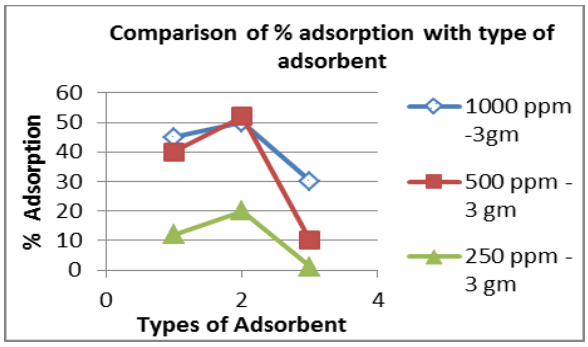

Fig.6:Comparison of % adsorption with type of adsorbent $K_2Cr_2O_7$.

It is observed Fig. 6 that % adsorption is a function of feed concentration and increases with increase in feed concentration for a particular type of adsorbent .This trend is seen in all the adsorbent synthesized in the present work.

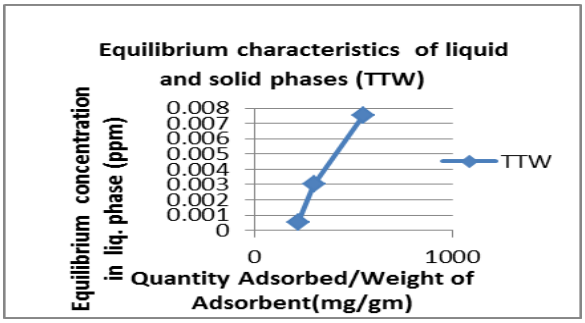

Fig. 7:Equilibriumcharacteristics of liquid and solid phases (TTW) of$K_2Cr_2O_7$.

The Fig.7 shows the relationship between the equilibrium concentration in liquid phase and solid phase for TTW adsorbent.It can be interpreted as linear equilibrium relationship holding good for system involved in Cr (VI) distributed between aqueous solution and thermally treated whole seed adsorbent.

V. CONCLUSION

Present work has addressed to the development of adsorbent from agro based waste materials such as '*Tectona grandis'* seeds. Thermal and boiling water treatment have been adopted in synthesis of three types of adsorbents namely Thermally treated whole seeds , Thermally treated particulate material & Raw boiled whole seed . In preliminary investigation 'Raw boiled whole seed' is found to be effective in 12 % adsorption of Victoria blue from synthetically prepared aqueous solution. Further the effectiveness of these adsorbents and their comparative studies has been carried out in removal of Cr (VI) from potassium dichromate aqueous solution. It is observed that these adsorbents are useful in removal of Cr (VI) from aqueous solution to the extent of 12 to 52 % depending upon the type of adsorbent and initial feed solution .

Based on the observation, results and discussion it can be inferred that thermally treated particulate adsorbent (TTP) is the best amongst the three adsorbents synthesized in the present work.

It can concluded that there is potential in adsorbent developed from ' *Tectona grandis* 'seed and need to be tapped further by conducting more such a experiments involving different types of adsorbents. There is need for characterization of adsorbent in assessing the usefulness and selection of synthesis method.

VI. REFERENCES

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