REMOVAL OF CHROMIUM (VI) FROM ELECTROPLATING WASTEWATER USING TEA WASTE

[1]Nikita K Parmar, [2]Dr. Reshma L. Patel
[1]Stuednt, [2]Associate Professor
[1]Department of civil engineering, Birla Vishvakarma Mahavidyalaya, V V Nagar, Gujarat, India
[2]Department of civil engineering, Birla Vishvakarma Mahavidyalaya, V V Nagar, Gujarat, India

ABSTRACT*:* Electroplating wastewater contains some heavy metals that pollute natural water. It is very difficult to treat it by conventional treatment processes due to its high cost and difficult operating conditions. Adsorption in one of the alternatives. As cost is important parameter low cost adsorbent getting interest. In this paper adsorption of chromium from electroplating industry by tea waste has been studied at laboratory scale. Electroplating waste was obtained from an industry in Vadodara district. Some parameters like initial pH, dosage of adsorbent, agitation speed and contact time were studied and optimum operational condition for chromium removal of wastewater was derived.

Keywords *Adsorption Process, Electroplating wastewaters, waste tea*

1. INTRODUCTION

1.1 Background

Dangerous metals are discharged into the nature by different mechanical exercises like refining minerals, compost businesses, mining, tanneries, and pesticides and so on. The major harmful metal particles which are dangerous to people and condition are Cr, Fe, Se, V, Cu, Co, Ni, Cd, Hg, As, Pb, Zn and so forth. These overwhelming metals are of explicit worry because of their poisonous quality, bio-aggregation inclination and persistency in nature. Different administrative bodies have set the most extreme endorsed limits for the release of poisonous substantial metals in the earth. Still the waste water containing overwhelming metals are being discharged at higher fixation into nature which influences the strength of people just as condition.

Some Conventional strategies for expulsion of metal particles from water bodies incorporate substance precipitation, particle exchangers, concoction oxidation/decrease, switch assimilation, electro dialysis, and ultra-filtration and so on. Anyway these regular strategies have a few confinements, for example, less productivity, delicate working conditions, and creation of auxiliary muck and further the transfer is exorbitant. Another option is adsorption of substantial metals by enacted carbon for treating waste water yet the surprising expense of initiated carbon and its misfortune amid the recovery confines its application.

As of late consideration has been redirected towards the waste materials which are created in a few ventures and horticulture exercises. The real points of interest of adsorption over regular treatment techniques are: ease, high effectiveness, minimization of compound or organic muck, no extra supplement prerequisite, and recovery of adsorbents and plausibility of metal recuperation.

Agrarian materials especially those containing cellulose indicates potential metal adsorption limit. The fundamental segments of the farming waste materials incorporate hemicelluloses, lignin, extractives, lipids, proteins, basic sugars, water hydrocarbons, starch containing assortment of useful gatherings that encourages adsorption of overwhelming metals on to the surface. Horticultural waste materials are monetary and eco inviting because of their one of a kind compound piece, accessibility in huge amount, sustainable, low in expense and more effectiveness.

Different rural waste materials, for example, rice grain, rice husk, wheat grain, wheat husk, saw residue of different plants, bark of the trees, ground nutshells, coconut shells, dark gram husk, walnut shells, cotton seed frames, squander tea leaves, cassia fistula leaves, maize corn cob, sugarcane, apple, banana, orange strips, soybean bodies, grapes stalks, espresso beans, cotton stalks and so on has been attempted. These horticultural waste materials are utilized in the evacuation of metal particles either in their normal structure or after some physical or synthetic change.

The electroplating industry is one such type of industry whose effluent is directly released into the fresh water bodies thus polluting the environment. The electroplating industry is a large industry operated throughout the year and generates a large amount of effluent which contains high load of heavy metals. The industry uses electrolytic processes for plating heavy metals on the metal sheet. During this process large quantities of heavy metals remain in the effluent. These effluents are released out openly into the environment and get mixed into the rivers and ponds. The channel of the effluent may have many cracks through which the polluted water gets percolated deep inside to contaminate the ground water.

In this research, tea waste is used to remove heavy metal chromium (VI) from electroplating industry waste water.

2 ADSORPTION USING TEA WASTE

2.1 Material pre-treatment

Before the use of tea waste it needs to go through some pre-treatments like washing and sieving. Washing of tea waste remove the considerable amount of hydrolysable tannins, polysaccharides and proteins along with other coloured and soluble components to avoid contamination. Distilled water was used to wash tea waste. The tea waste was washed until a colourless solution remained. Washed Tea waste was then dried in an oven for 48 hours at 180°C. Then desired particle size of tea waste was obtained by sieving.

2.2 Methodology

UV-VIS Spectrophotometer was used to measure chromium concentration using the method based on the reaction of Cr (VI) and diphenyl carbazide which forms a red-violet coloured complex. Standard calibration curve was obtained by taking different amount of Cr in $K_2Cr_2O_7$.

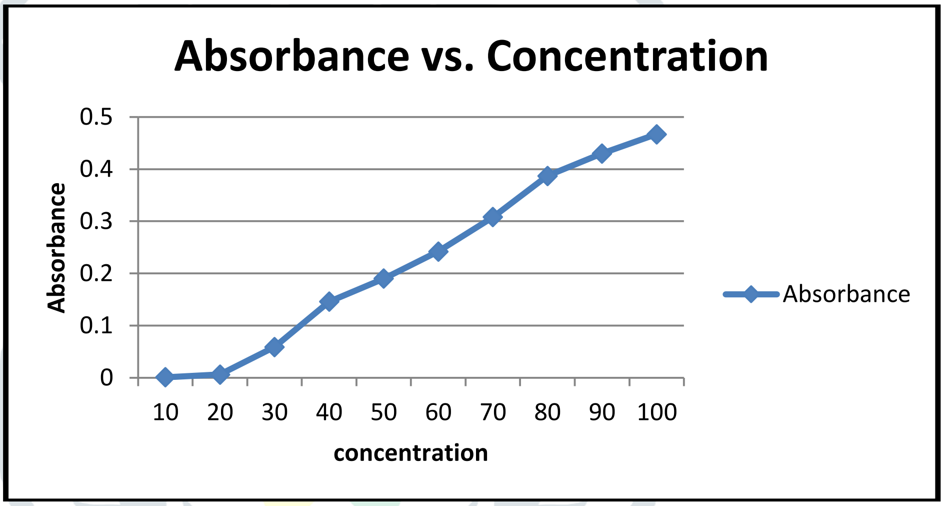
Experiments were conducted in the 250ml flask. 200ml of unknown sample was taken for each set of experiment. Experiments were done at different pH values ranging from 1-3, different adsorbent dose ranging from 3 to 5 g/200ml, different agitation speeds 200, 360 and 480 rpm. Samples were taken at time interval of 15 min (15, 30, 45, 60, 75, 90, 105, and 120) to find optimum contact time. Magnetic stirrer was used to maintain speed.

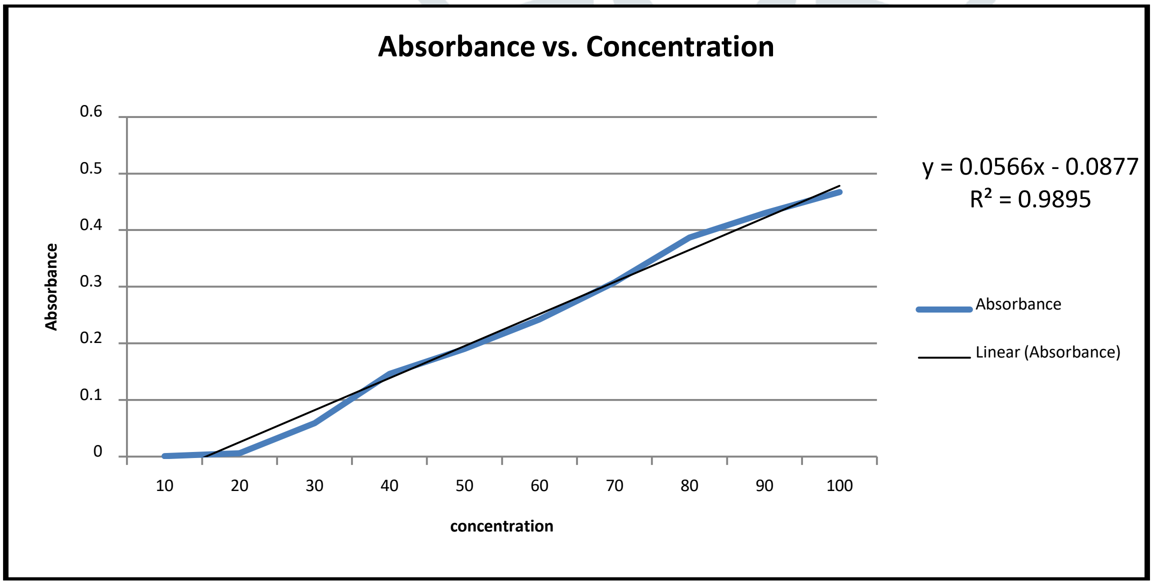
Initial pH of wastewater was 3.0. To vary pH, 1.0 m HCl was used.

Initial chromium concentration was 117.474 µg/ml.

Calibration curve:

Std Concentration	Absorbance
10	0.001
20	0.006
30	0.059
40	0.146
50	0.19
60	0.242
70	0.308
80	0.387
90	0.43
100	0.467





3. Results and discussion

3.1 Effect of pH

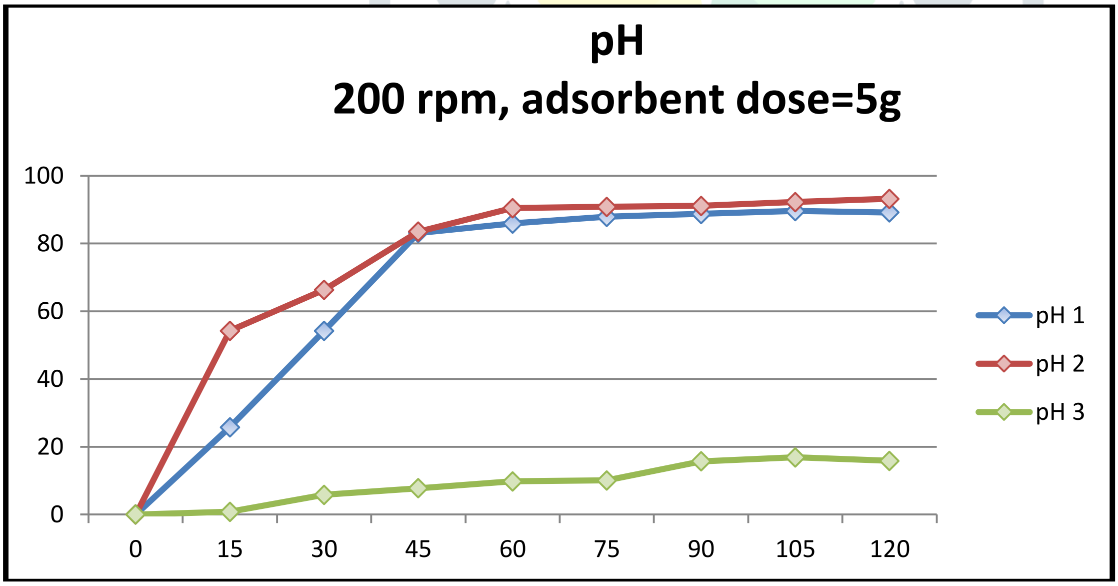
The pH of the solution is an effective controlling parameter. Thus the ion concentration was examined at different pH, covering a range of 1.0 to 3.0.

A graph was plotted of % reduction vs. Time keeping other parameters constant. Speed was constant 200rpm, adsorbent dose was taken 5g, and effects of pH 1.0, 2.0 and 3.0 were examined.

pH = 1		
Time (min)	Concentration(µg/ml)	% reduction
0	117.474	0
15	87.222	25.75
30	53.756	54.24
45	19.8275	83.12
60	16.55	85.911
75	14.232	87.88
90	13.225	88.742
105	12.22	89.59
120	12.69	89.19

pH = 2		
Time (min)	Concentration(µg/ml)	% reduction
0	117.474	0
15	53.756	54.24
30	39.551	66.33
45	19.367	83.51
60	11.225	90.44
75	10.75	90.84
90	10.435	91.117
105	9.09	92.262
120	8.002	93.188

pH = 3		
Time (min)	Concentration(µg/ml)	% reduction
0	117.474	0
15	116.542	0.79
30	110.632	5.82
45	108.36	7.758
60	105.98	9.784
75	105.66	10.054
90	99.002	15.724
105	97.664	16.86
120	98.887	15.822



The maximum removal of chromium was found at pH = 2.

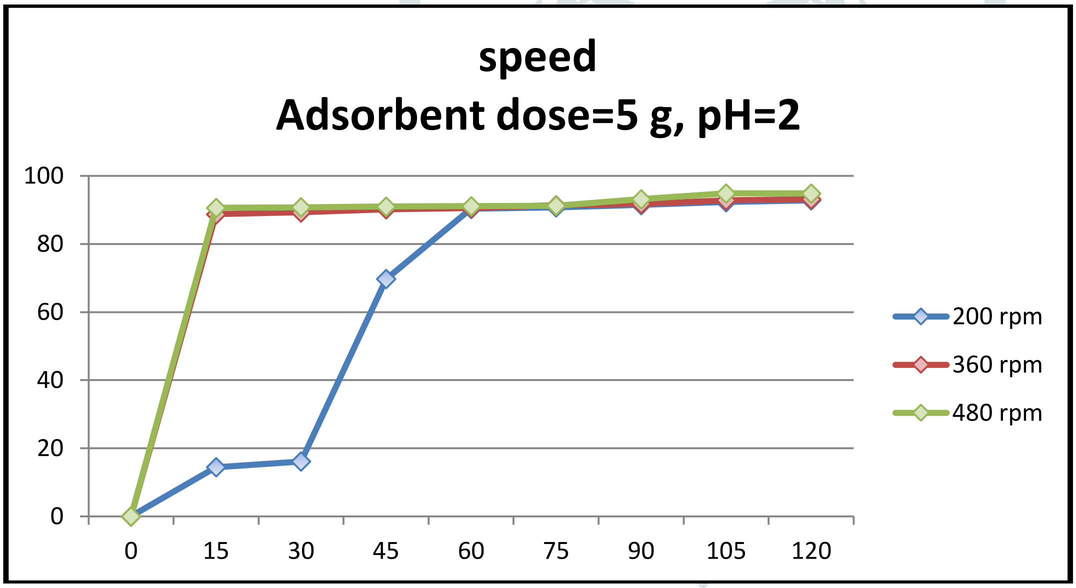
3.2 Effect of speed

The speed considerably affects the removal of chromium concentration. Speed 200rpm, 360rpm and 480rpm were examined.

200 rpm		
Time (min)	Concentration(μg/ml)	% reduction
0	117.474	0
15	100.517	14.434
30	98.521	16.133
45	35.5695	69.72
60	11.32	90.363
75	10.849	90.764
90	10	91.487
105	9	92.338
120	8.4	92.84

360 rpm		
Time (min)	Concentration(μg/ml)	% reduction
0	117.474	0
15	13.221	88.745
30	12.554	89.31
45	11.5	90.21
60	11.03	90.61
75	10.09	91.41
90	9.62	91.81
105	8.4	92.84
120	8	93.189

480 rpm		
Time(min)	Concentration(μg/ml)	% reduction
0	117.474	0
15	11.003	90.633
30	10.849	90.764
45	10.566	91.005
60	10.435	91.117
75	10.283	91.24
90	8	93.189
105	6	94.892
120	6	94.892



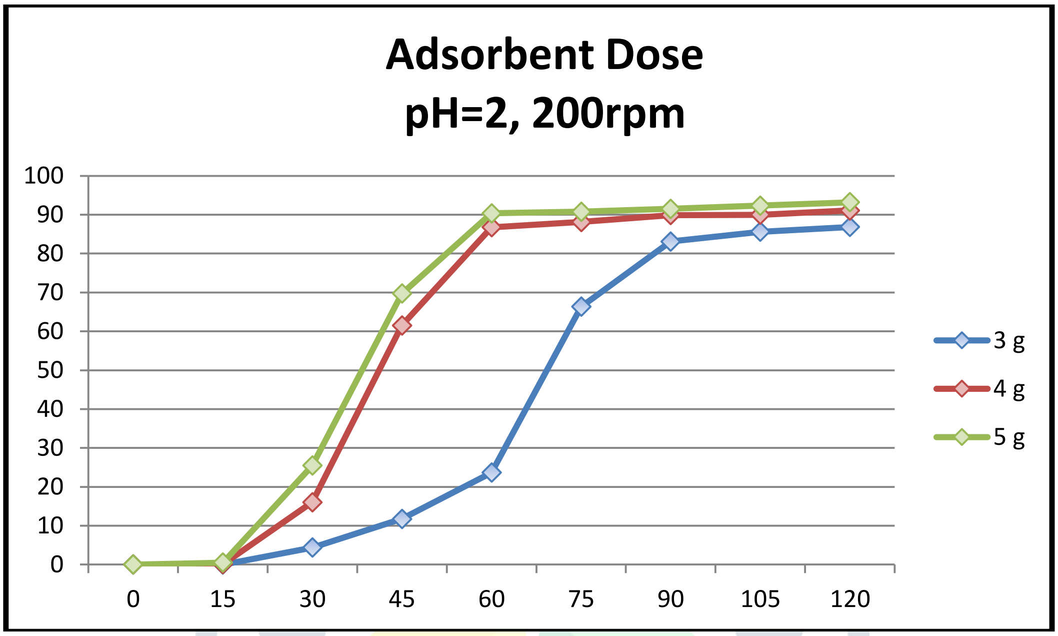
From results we can conclude that 200 rpm speed is enough for chromium removal as there is no more difference between % reduction at 200, 360 and 480 rpm

3.3. Effect of Adsorbent dose

3 g		
Time (min)	Concentration(μg/ml)	% reduction
0	117.474	0
15	117.474	0
30	112.323	4.385
45	103.650	11.768
60	89.68	23.66
75	39.551	66.332
90	19.828	83.122
105	16.89	85.622
120	15.447	86.851

4 g		
Time (min)	Concentration(μg/ml)	% reduction
0	117.474	0
15	117.361	0.096
30	98.62	16.05
45	45.221	61.506
60	15.52	86.789
75	13.96	88.117
90	11.856	89.908
105	11.784	89.969
120	10.47	91.087

	5 g	
Time(min)	Concentration(µg/ml)	% reduction
0	117.474	0
15	116.897	0.491
30	87.561	25.464
45	35.5695	69.721
60	11.32	90.364
75	10.849	90.765
90	10	91.487
105	9	92.339
120	8	93.19



Maximum removal was observed at 5g adsorbent dose. 93% removal was obtained at 25 gL^{-1} adsorbent dose.

3.4 Effect of contact time

From above all experiments we can conclude that 60min is an optimum contact time. Maximum removal was observed upto 60min. After that removal was almost constant. 90% removal has been observed at 60min.

4. Conclusion

Following conclusion can be drawn from the present study:

1. The present experiment shows that the tea waste is an effective adsorbent for the removal Cr (VI).
2. The adsorption process is the function of pH, agitation speed, Adsorbent dose, and contact time.
3. Adsorption is maximum at pH=2.
4. As adsorbent dose increases, removal of chromium ion increases.
5. With the increase in contact time, adsorption increases, and maximum adsorption takes place in 60 min.
6. Agitation speed of 200rpm is enough for this process because all agitation speeds show almost same results.

5. References

1] Ajmal, Mohammad, et al. "Adsorption studies on Citrus reticulata (fruit peel of orange): removal and recovery of Ni (II) from electroplating wastewater." *Journal of hazardous materials* 79.1-2 (2000): 117-131.

2] Cay, S., A. Uyanık, and A. Özaşık. "Single and binary component adsorption of copper (II) and cadmium (II) from aqueous solutions using tea-industry waste." *Separation and Purification Technology* 38.3 (2004): 273-280.

3] Eroğlu, Hayrettin, et al. "An environmentally friendly process; Adsorption of radionuclide Tl-201 on fibrous waste tea." *Journal of hazardous materials* 163.2-3 (2009): 607-617.

4] Gautam, Anamika, et al. "Green synthesis of iron nanoparticle from extract of waste tea: An application for phenol red removal from aqueous solution." *Environmental Nanotechnology, Monitoring & Management* (2018).

5] Gupta, Vinod K., et al. "Removal of cadmium and nickel from wastewater using bagasse fly ash—a sugar industry waste." *Water research* 37.16 (2003): 4038-4044.

6] Hameed, Bassim H. "Spent tea leaves: a new non-conventional and low-cost adsorbent for removal of basic dye from aqueous solutions." *Journal of hazardous materials*161.2-3 (2009): 753-759.

7] Hu, Jing, Guohua Chen, and Irene MC Lo. "Selective removal of heavy metals from industrial wastewater using maghemite nanoparticle: performance and mechanisms." *Journal of environmental engineering* 132.7 (2006): 709-715.

8] Kadirvelu, K., K. Thamaraiselvi, and C. Namasivayam. "Removal of heavy metals from industrial wastewaters by adsorption onto activated carbon prepared from an agricultural solid waste." *Bioresource technology* 76.1 (2001): 63-65.

9] Lunge, Sneha, Shripal Singh, and Amalendu Sinha. "Magnetic iron oxide (Fe3O4) nanoparticles from tea waste for arsenic removal." *Journal of Magnetism and Magnetic Materials* 356 (2014): 21-31.

10] Malkoc, Emine, and YasarNuhoglu. "Fixed bed studies for the sorption of chromium (VI) onto tea factory waste." *Chemical Engineering Science* 61.13 (2006): 4363-4372.

11] Malkoc, Emine, and YasarNuhoglu. "Investigations of nickel (II) removal from aqueous solutions using tea factory waste." *Journal of Hazardous Materials* 127.1-3 (2005): 120-128.

12] Malkoc, Emine, and YasarNuhoglu. "Potential of tea factory waste for chromium (VI) removal from aqueous solutions: Thermodynamic and kinetic studies." *Separation and Purification Technology* 54.3 (2007): 291-298.

13] Malkoc, Emine, and YasarNuhoglu. "Removal of Ni (II) ions from aqueous solutions using waste of tea factory: Adsorption on a fixed-bed column." *Journal of Hazardous Materials*135.1-3 (2006): 328-336.

14] Nandal, Meenakshi, RajniHooda, and GeetaDhania. "Tea wastes as a sorbent for removal of heavy metals from wastewater." *Int. J. Curr. Eng. Technol* 4.1 (2014): 244-247.

15] Nasuha, N., B. H. Hameed, and Azam T. Mohd Din. "Rejected tea as a potential low-cost adsorbent for the removal of methylene blue." *Journal of hazardous materials* 175.1-3 (2010): 126-132.

16] Nuhoglu, Y., et al. "The removal of Cu (II) from aqueous solutions by Ulothrixzonata." *Bioresource Technology* 85.3 (2002): 331-333.

17] Orhan, Y., and H. Büyükgüngör. "The removal of heavy metals by using agricultural wastes." *Water Science and Technology*28.2 (1993): 247-255.

18] Panneerselvam, P., NorhashimahMorad, and KahAik Tan. "Magnetic nanoparticle (Fe3O4) impregnated onto tea waste for the removal of nickel (II) from aqueous solution." *Journal of hazardous materials* 186.1 (2011): 160-168.

19] Periasamy, K., and C. Namasivayam. "Removal of nickel (II) from aqueous solution and nickel plating industry wastewater using an agricultural waste: peanut hulls." *Waste management*15.1 (1995): 63-68.

20] Poguberović, Sofija S., et al. "Removal of As (III) and Cr (VI) from aqueous solutions using "green" zero-valent iron nanoparticles produced by oak, mulberry and cherry leaf extracts." *Ecological Engineering* 90 (2016): 42-49.

21] Sharma, Y. C., and V. Srivastava. "Separation of Ni (II) ions from aqueous solutions by magnetic nanoparticles." *Journal of Chemical & Engineering Data* 55.3 (2009): 1441-1442.

22] Sharma, Y. C., et al. "Removal of Cr (VI) from wastewater by adsorption on iron nanoparticles." *The Canadian Journal of Chemical Engineering* 87.6 (2009): 921-929.

23] Sharma, Y. C., G. Prasad, and D. C. Rupainwar. "Removal of Ni (II) from aqueous solutions by sorption." *International journal of environmental studies* 37.3 (1991): 183-191.

24] Singh, S. R., and A. P. Singh. "Adsorption of heavy metals from waste waters on tea waste." *Global Journal of Research Engineering* 12.1 (2012): 19-22.

25] Sud, Dhiraj, Garima Mahajan, and M. P. Kaur. "Agricultural waste material as potential adsorbent for sequestering heavy metal ions from aqueous solutions–A review." *Bioresource technology* 99.14 (2008): 6017-6027.

26] Suemitsu, R., et al. "The use of dyestuff-treated rice hulls for removal of heavy metals from waste water." *Journal of Applied Polymer Science* 31.1 (1986): 75-83.

27] Tee, Tan Wee, and Abd Rahman Majid Khan. "Removal of lead, cadmium and zinc by waste tea leaves." *Environmental Technology* 9.11 (1988): 1223-1232.

28] Uddin, MdTamez, et al. "Adsorptive removal of methylene blue by tea waste." *Journal of Hazardous Materials* 164.1 (2009): 53-60.

29] Villaescusa, Isabel, et al. "Removal of copper and nickel ions from aqueous solutions by grape stalks wastes." *Water research* 38.4 (2004): 992-1002.

30] Wasewar, Kailas L. "Adsorption of metals onto tea factory waste: a review." *Int. J. Res. Rev. Appl. Sci* 3.3 (2010): 303.