ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 5, March 2018

Fluoride removal from aqueous solution using Psidium guajava and Mimosa pudica Leaves

J. Sharpudin[1], Barisha Kharjana[2], K. Balakumar[3], P. Priyadarshini[4]

[1,3,4]Assistant Prof., Department of Civil Engineering, C. Abdul Hakeem College of Engineering and Technology, Vellore, Tamil Nadu, India

[2] P.G. Student, M.E. Environmental Engineering, C. Abdul Hakeem College of Engineering and Technology, Vellore, Tamil Nadu, India

Abstract: This paper investigate the used of natural adsorbent for fluoride removal namely *Psidium guajava* (Guava) and *Mimosa pudica* (Touch-Me-Not) leaves carried out at varied pH, contact time and adsorbent dosage. The characteristics of adsorbent were determined such as moisture content (%), bulk density (g/cm^3), particle density (g/cm^3), water solubility (%), acid solubility (%). The optimum pH was found to be 6 for Guava leave and 5 for Touch-Me-Not leave. The optimum dose was found to be 0.75 mg and optimum contact time of 150 min for both the leaves efficiency of 94%, 90%, 96% and 94% was observed.

Keywords: Fluoride aqueous solution, low-cost adsorbent, adsorption, characterization, Guava and Touch-Me-Not leaves.

I. INTRODUCTION

Safe drinking water is one of the important source for human being . Pure water is not easily available. One of the major contaminants for water is fluoride [1]. Fluoride occurrence in water is due to two factors: natural and man-made source [2]. Depending on fluoride concentration in water maybe both beneficial and also have an effects on human health [4]. Above 1.5 mg/l of fluoride concentration cause dental and skeletal fluorosis, destruction of enamel of teeth [5] but if below 1.5 mg/l F^- which is the permissible limit according to World Health Organisation (WHO), have beneficial for treating dental carries in children. The dental and skeletal fluorosis are irreversible in which no treatment is available.

According to International Society for Fluoride Research (ISFR) has implement that increasing rate of fluoride leads to Down's Syndrome, sleeping disorder and Chromic fatigue Syndrome (A.V.Jamode et al. 2004).

To overcome the problem of excess fluoride in water, several researchers have focus on different types of defluoridation techniques. Various techniques have been developed which include membrane separation, natural zeolite, nano-filtration, reverse osmosis, ion-exchange fiber, granular red mud, carbon- nanotubes, precipitation, adsorption. Among several treatment for fluoride removal, adsorbent has been widely used because of its robust, simple and environmental friendly.

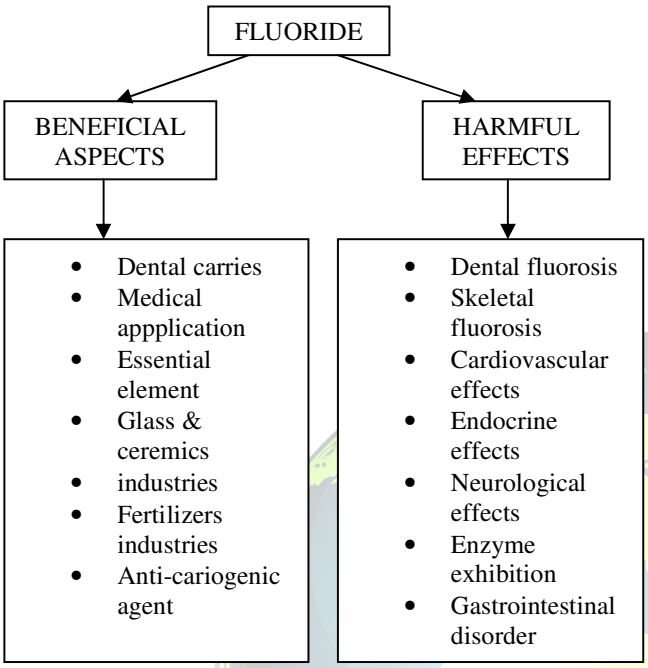
Cost-effective adsorbent widely used are tamarind shell, moringa oleifera, groundnut shell carbon, eggshell powder, walnut shell carbon, date palm, rice husk, neem leave, guava leave, activated alumina, lemon leave, Peepal Leave. Fluoride bearing rocks are abundant in India, as a result, fluoride leaches out and contaminates the soil resources and adjacent water. High concentration cause serious problem for human health, animals and may varied from country-to-country. Elemental fluoride is more toxic than its salts. Inteference of halide with lipids, carbohydrates, proteins, vitamins and mineral metabolism is contributed to high concentration of fluoride which cause dental and skeletal pathology (Gong et al., 2012).

Skeletal pathology affects youngsters. Halide gets deposited within the joints of neck, knee, girdle and shoulder bones and make it troublesome to move or walk. The early symptoms include unpredictable pain, back stiffness, burning like sensation, muscle weakness. Whereas dental pathology characterized by white, opaque areas on the tooth surface, discoloration, spots or horizontal streaks [33].

Psidium guajava leave is a tropical plant belonging to Myrtaceae family easily available in India. Raw leaves contain compounds namely resin, volatile oil, tannin and properties like antioxidant, antidiabetic, antibacterial and anticough used for treatment purpose [24]. *Mimosa pudica* also have properties of anticancer alkaloid, antimalarial, antidepressant, antiparasitic, antimicrobial.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 5, March 2018



II. MATERIALS AND METHODS

A. *Adsorption study*

In all the experiment, 100 ml measuring flask were used containing 50 ml fluoride solution of known concentration (9 mg/l) common to 5 measuring flasks at different pH, contact time and adsorbent dosage. The filtrate was then filtered by whatmann filter paper and was used for fluoride analysis using Fluoride Kit.

B. *Stock solution preparation*

Fluoride stock solution was prepared by taking 221.01 mg of sodium fluoride (NaF) dissolved in 1L distilled water. 100 ppm of fluoride contain in the stock solution.

C. *Adsorbent preparation*

Psidium guajava and *Mimosa pudica* leaves where collected in and around Melvisharam area, Vellore District.

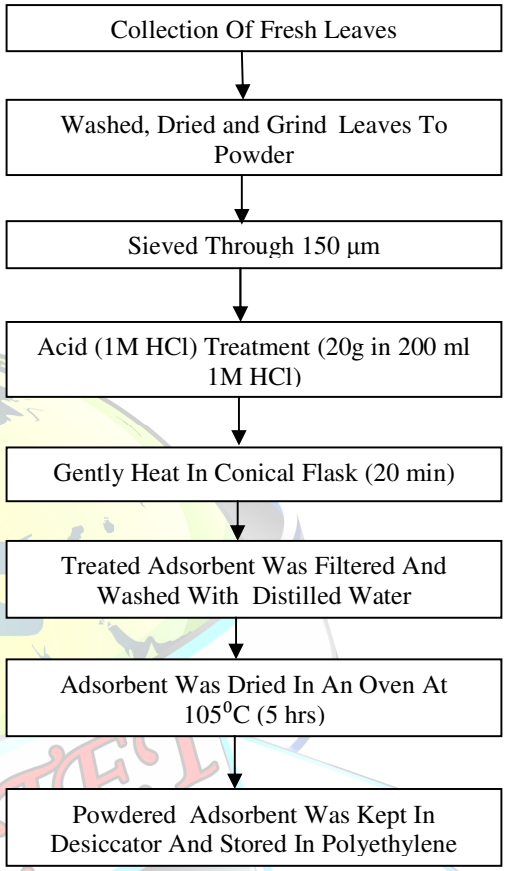


Fig. 1 PREPARATION OF ADSORBENT

III. RESULTS AND DISCUSSION

TABLE 1
CHARACTERIZATION OF ADSORBENTS

Parameters	Guava Leaves	Touch-Me-Not
Bulk density (g/cm^3)	0.43	0.45
Particle density (g/cm^3)	0.48	0.50
Water soluble (%)	1.32	1.00
Acid soluble (%)	3.00	1.80
Moisture content (%)	2.46	2.00

Note: Adsorbents were characterised according to European Council of Chemical Manufacturer's Federation (CEFIC).

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 5, March 2018

A. *Effect of pH*

A known amount of adsorbent dosage 0.55 mg were added to each 50 ml fluoride solution in a measuring flask containing 9 mg/l of initial fluoride concentration and then agitated on a orbital shaker at a speed of 120 rpm for 150 min contact time with varying pH 2, 4, 5, 6 and 7 as shown in Fig. 2. One of the controlling factor of adsorption is pH of aqueous solution which denotes the hydrogen (H^+) ion concentration in solution. This experimental work is similar with Sheo Prasad *et al.*,(2016) [24] work, when pH is above 6.5, percentage of fluoride removal decreased. Thus, pH-6 was proceed for further experiment.

B. *Effect of Contact time*

A known amount of adsorbent dosage 0.55 mg were added to each 50 ml fluoride solution in a measuring flask containing 9 mg/l of initial fluoride concentration and then agitated on a orbital shaker at a speed of 120 rpm at pH-6 with varying contact time 30, 60, 90, 120 and 150 min. Optimum time is obtained at 150 min (Fig. 3) contact time which specific time needed to obtained an equilibrium between solution and surface adsorbents, to ensure the end of adsorption process (Abas *et al.*, 2013) [31].

C. *Effect of Adsorbent Dosage*

With varying adsorbent dosage 0.15, 0.35, 0.55, 0.75 and 0.95 mg were added to each 50 ml fluoride solution in a measuring flask containing 9 mg/l of initial fluoride concentration and then agitated on a orbital shaker at a speed of 120 rpm for 150 min contact time at pH-6. From Fig. 4 fluoride increase with increase in adsorbent dosage and attains equilibrium at 0.75 and 0.95 mg. Shashikant R.Mise *et al.*, (2014) [32] investigated for fluoride removal efficiency on Phoenix Dactylifera which is similar with this experimental work.

Table 2 Operating condition for effect of pH

Adsorbent dosage	0.75 mg (Guava Leave and Touch-Me-Not)
Time of contact	150 min
Volume of sample	50 ml

Table 3 Effect of pH

	pH	Initial Fluoride Conc. C_O (mg/l)	Final Conc. C_e (mg/l)	Removal % Of Fluoride
Guava Leaves	2	9	1.80	80
	4	9	1.62	82
	5	9	1.10	87
	6	**9**	**0.54**	**94**
	7	9	0.59	93
Touch-Me-Not	2	9	4.00	55
	4	9	2.10	76
	5	**9**	**0.90**	**90**
	6	9	1.44	84
	7	9	1.44	84

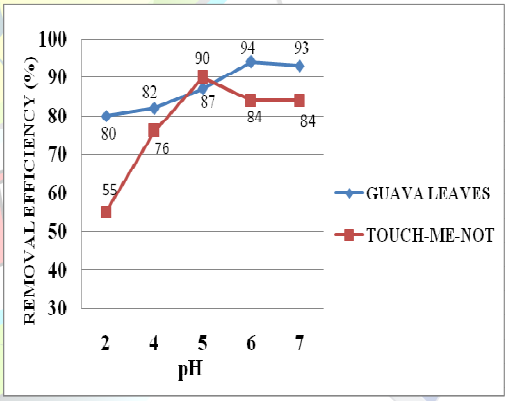


Fig. 2 pH vs Removal % of fluoride

Table 4 Operating condition for effect of contact time

Adsorbent dosage	0.75 mg (Guava Leave and Touch-Me-Not)
pH	6
Volume of sample	50 ml

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 5, March 2018

Table 5 Effect Of Contact Time (min)

	Contact Time (min)	Initial Fluoride Conc. C_O (mg/l)	Final Conc. C_e (mg/l)	Removal % Of Fluoride
Guava Leaves	30	9	4.5	50
	60	9	2.7	70
	90	9	1.8	80
	120	9	1.23	86
	150	**9**	**1.00**	**90**
Touch-Me-Not	30	9	4.00	55
	60	9	3.20	64
	90	9	2.40	73
	120	9	1.28	86
	150	**9**	**0.80**	**91**

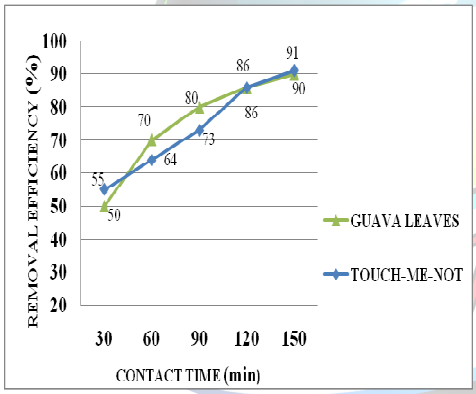


Fig. 3 Contact Time vs Removal % of fluoride

Table 7 Effect of adsorbent dosage

	Adsorbent Dosage (mg)	Initial Fluoride Conc. C_O (mg/l)	Final Conc. C_e (mg/l)	Removal % Of Fluoride
Guava Leaves	0.15	9	4.50	50
	0.35	9	3.60	60
	0.55	9	1.62	82
	0.75	**9**	**0.32**	**96**
	0.95	**9**	**0.32**	**96**
Touch-Me-Not	0.15	9	5.60	38
	0.35	9	4.00	55
	0.55	**9**	**0.56**	**94**
	0.75	9	1.28	86
	0.95	9	1.28	86

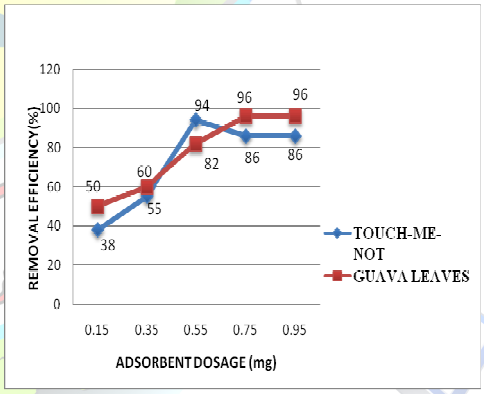


Fig.4 Adsorbent dose vs Removal % of fluoride

Table 6 Operating condition for effect of Adsorbent dosage

Time	150 min
pH	6 (Guava Leave and Touch-Me-Not)
Volume of sample	50 ml

IV. CONCLUSION

- From the overall pH study, using Guava leaves powder adsorbent the percentage of fluoride removal increase as pH increase from 2 to 6, the maximum was obtained **94% at pH 6.** Touch-Me-Not maximum was obtained 90% at pH 5.
- From the overall contact time study, using Guava leaves leaves powder adsorbent the percentage fluoride removal increase with increase in time from 30 to 150 min, the maximum was obtained **90% at 150 min.** Touch-Me-Not maximum was obtained 91% at 150 min.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 5, Special Issue 5, March 2018

- From the overall dosage study, Guava leaves maximum was obtained 96% at 0.75 mg, Touch-Me-Not maximum was obtained 94% at 0.55 mg.

REFERENCES

[1] A.S. Parlikar *et al.,* "Defluoridation Of Water by Moringa Oleifera- A Natural Adsorbent", International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 2, Issue 5, September 2013.

[2] Swaty P.S *et al.,* "Defluoridation of water using Neem (*Azadirachta indica*) leaf as adsorbent", IJARIIE-ISSN(O)-2395-4396, Vol-3 Issue - 4 2017.

[3] S. Velizarov, J.G. Crespo, M.A. Reis, Removal of inorganic anions from drinking water supplies by membrane bio/processes, Rev. Environ. Sci. Biotechnol., 3 (2004) 361–380.

[4] Sheo Prasad Shukla *et al.,* "Removal of fluoride from aqueous solution using *Psidium guajava* leaves", Desalination and Water Treatment (2016) 1–8.

[5] Swaty P.S *et al.,* "Defluoridation of water using Neem (*Azadirachta indica*) leaf as adsorbent", IJARIIE-ISSN(O)-2395-4396, Vol-3 Issue - 4 **2017**.

[6] P. K. Shrivastava and A. Deshmukh, "Defluoridation of Water with Natural Zeolite," *Journal of the Institution of Public Health Engineers* (*India*), Vol. 14, No. 2, 1994, pp. 11-14.

[7] P.I. Ndiaye, P. Moulin, L. Dominguez, J.C. Millet, F. Charbit, Removal of fluoride from electronic industrial effluent by RO membrane separation, Desalination, 173 (2005) 25–32.

[8] K. Hu, J.M. Dickson, Nano-filtration membrane performance on fluoride removal from water, J. Membr. Sci., 279 (2006) 529–538.

[9] J. Shen, A. Schafer, Removal offluoride and uranium by nano-filtration and reverse osmosis: a review, Chemosphere, 117 (2014) 679–691.

[10] R. X. Liu, J. L. Guo and H. X. Tang, "Adsorption of Fluoride, Phosphate, and Arsenate Ions on a New Type of Ion Exchange Fiber," Journal of Colloid and Interface Science, Vol. 248, No. 2, 2002, pp.268-274.

[11] A. Tor, N. Danaoglu, G. Arslan and Y. Cengeloglu, "Re- moval of Fluoride from Water by Using Granular Red Mud: Batch and Column Studies," Journal of Hazardous Material, Vol. 164, No. 1,2009, pp. 271-278.

[12] Y. Cengeloglu, E. Kir and M. Ersoz, "Removal of Fluo-ride from Aqueous Solution by Using Red Mud," Separa-tion and Purification Technology, Vol. 28, No. 1, 2002, pp. 81-86.

[13] Y. H. Li, S. Wang, A. Cao, D. Zhao, X. Zhang, J. Wei, C. Xu, Z. Luan, D. Ruan, J. Liang, D. Wu and B. Wei, "Ad-sorption of Fluoride from Water by Amorphous Alumina Supported on Carbon Nanotubes," Chemical Physics Letters, Vol. 350, No. 5, 2001, pp. 412-416.

[14] M.F. Chang, J.C. Liu, Precipitation removal of fluoride from semiconductor wastewater, J. Environ. Eng., 133 (2007) 419–425.

[15] R. S. Sathish, N. S. R. Raju, G. S. Raju, G. N. Rao, K. A. Kumar and C.Janardhana, "Equilibrium and Kinetic Stu-dies for Fluoride Adsorption from Water on Zirconium Impregnated Coconut Shell Carbon," Separation and Pu-rification Technology, Vol. 42, No. 2007, pp. 769-788.

[16] V. Ramanjaneyulu *et al.,* "Kinetic studies on deduction of fluoride from drinking water by using Tamarind shell and pipal leaf powder", International Journal of Emerging Trends in Engineering and Development, (September 2013) Vol.5, Issue 3, pp. 146-155.

[17] Alagumuthu *et al.,* "Fluoride removal capacity of zirconium impregnated groundnut shell carbon (ZIGNSC) from water ", ISSN: 2277- 9655, 5(10): October, 2016.

[18] R. Bhaumik *et al.,* "Eggshell Powder as an Adsorbent for Removal of Fluoride from Aqueous Solution: Equilibrium, Kinetic and Thermodynamic Studies", E-Journal of Chemistry 2012, 9(3),1457-1480.

[19] Rajan *et al.,* "The fluoride removal capacity of zirconium impregnated walnut shell carbon (ZIWSC)", ISSN: 2277-9655.

[20] Shashikant R.Mise *et al.,* "Fluoride Removal from Water Using Activated Carbon Derived From Phoenix Dactylifera (Date Palm) Seeds", ISSN: 2348-4748, Volume 1, Issue 4, April 2014.

[21] Waheed S. Deshmukh *et al.,* "Investigation on Sorption of Fluoride in Water Using Rice Husk as an Adsorbent", International Quarterly Scientific Journal - Vol. 8 No. 2 pp. 217-223, 2009.

[22] Sutapa Chakrabarty and H.P.Sarma, "Defluoridation of contaminated drinking water using neem charcoal adsorbent: Kinetics and equilibrium studies", International Journals of Chem Tech Research. Vol.4, No.2, April-June 2012, 511-516.

[23] Asha Gupta *et al.,* "Removal of fluoride by thermally activated carbon prepared from neem (*Azadirachta indica*) and kikar (*Acacia arabica*) leaves", Journal of Environmental Biology March 2008, 29(2) 227-232.

[24] Hugo Alberto Sánchez-Sánchez *et al.,* "Fluoride Removal from Aqueous Solutions by Mechanically Modified Guava Seeds", International Journal of Sciences: Basic and Applied Research (IJSBAR) (2013) Volume 11, No 1, pp 159-172.

[25] M. Srimurali *et al.,* "Activated alumina: defluoridation of water and household application – a study", Twelfth International Water Technology Conference, IWTC12 2008, Alexandria, Egypt.

[26] D.S. Malik *et al.,* "Preparation and characterization of plant based low cost adsorbent", Journal of Global Biosciences Vol. 4, SI 1, 2015 pp, 1824-1829.

[27] S.S. Tripathy *et al.,* "Removal of fluoride from drinking water by adsorption onto alum-impregnated activated alumina, Sep. Purif. Technol., 50 (2006) 310-317.

[28] Tomar Vaishali *et al.,* (2014), " Adsorptive removal of fluoride from aqueous media using Citrus limonum (lemon) leaf ", Microchemical Journal 112 97–103.

[29] Shubha Dwivedi *et al.,* " Bioadsorption of Fluoride by Ficusreligiosa (Peepal Leaf Powder): Optimization of process Parameters and Equilibrium study", Research Journal of Chemical Sciences Vol. 4(7), 52-60, July (2014)

[30] Abas Siti Nur Aeisyah *et al.,* "Adsorption Process of Heavy Metals by Low-Cost Adsorbent: A Review", World Applied Sciences Journal. 2013; 28(11):1518-1530.

[31] Shashikant.R.Mise *et al.,* "Fluoride Removal from Water Using Activated Carbon Derived From Phoenix Dactylifera (Date Palm) Seeds", International Journal of Ethics in Engineering & Management Education ISSN: 2348-4748, Volume 1, Issue 4, April 2014.

[32] Jagvir singh *et al.,* "Fluoride ions vs removal technologies: A study", Science direct Arabian Journal of Chemistry, Nov 2016, Pg 815-824.