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Groundwater Quality in Kovilpatti Region and Removal of Fluoride using Neem (Azadirachta Indica) Leaves as an Adsorbent

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Abstract: ***Groundwater pollution is a worldwide issue. The level of the pollutant concentration measurement is an essential due to the many countries depend on groundwater for the drinking. In present study area (Kovilpatti region) has also depend on groundwater for the drinking and irrigation purposes. Hence to assess the ground water quality in Kovilpatti region, 18 samples were collected from various points during pre-monsoon sessions (January 2020). The physical water quality parameters such as pH, TDS, EC were measured in the field using handheld water analysis kit. The chemical parameters of water quality such as Chloride (Cl^-), Fluoride (F^-), iron (Fe^{2+}) were analyzed and concentration were computed in the laboratory by using standard methods. Among the obtained values, five stations have higher concentration of chloride and fluoride than the permissible limit recommended in BIS 2012. To reduce the fluoride concentration, a treatment was carried out using Neem leaves as natural adsorbent. The obtained result reveals that the removal efficiency is about 52% when 0.04g of adsorbent was added. For the same, a station named Pudhukramam, achieved the maximum removal efficiency as 87%. This study is used to assess the level of pollution and pollutant concentration in the Kovilpatti region. The removal efficiency of Neem levels at varies additions were also measured in the present study.***

Keywords: Fluoride removal – Groundwater pollution – Neem leaves - Water quality analysis.

I. INTRODUCTION

Groundwater is the primary sources for drinking in many parts of the world. Groundwater is used for various purposes such as for agricultural, Industrial activity and human activities [1].

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Many point and non-point sources are responsible for the groundwater contamination. The contaminating substances are classified based on the origin. Ground water pollution occurs by various sources like sewage, dumping the industrial waste, leakage of oil, leaching of chemicals from rocks, disposal from match industries through drainage etc [2, 3]. The polluted groundwater is impossible to treat inside the ground naturally; hence treatment of ground water is needed after the withdrawal and before drinking and other purpose. Adsorption is one of the techniques to treat the polluted groundwater. It is a surface phenomenon with the mechanism of organic and inorganic pollutants removal. When solution containing absorbable solute (polluting substance) comes into contact with a solid (Adsorbent) with a highly porous surface, liquid–solid intermolecular forces of attraction cause solute molecules deposited at the solid surface [4]. Different types of adsorbents are used to treat polluted water i.e. natural adsorbents and synthetic adsorbents. Azadirachta Indica is a natural adsorbent and it is used for this study. Azadirachta Indica is popularly called as Neem tree belongs to the family Meliaceae. Neem leaves have high potential to reduce the concentration of certain ions from water [5, 6]. The study area is a partially hilly area and different type of rocks was found. The industry like match works and cotton are present in the study area. The source of contamination is generally classified as organic and inorganic. From the industry disposal includes chemical waste such as red phosphorous, nitrogen and it causes lot of health issues to humans living in that area like fluorosis, cancer , difficulty in breathing etc. The effects of groundwater pollution in Kovilpatti is due to the discharge of red phosphorus from match industries and others causes nausea, vomiting, abdominal pain to the people living around that area. Added to it, the percolation of rainwater into the ground through the rocks causes chemical contamination in ground water leads to the health hazards. Hence the treatment of ground water may be essential in Kovilpatti before it is used for drinking.

II. STUDY AREA AND METHODS

A. Study Area

In this project we had chosen our study area as Kovilpatti, located in the Latitude 9.1727˚ North and Longitude 77.87˚ East (Fig 1).

Based on the census record of 2011 Kovilpatti has population as 95,097 over 49 km^2. It is a special grade municipality in Thoothukudi district in the Indian state of Tamilnadu.

It is the second largest town in the district with different industries and geographical features [7]. The study area is chosen as Kovilpatti in order to determine the water quality and to suggest natural adsorbent to treat the water.

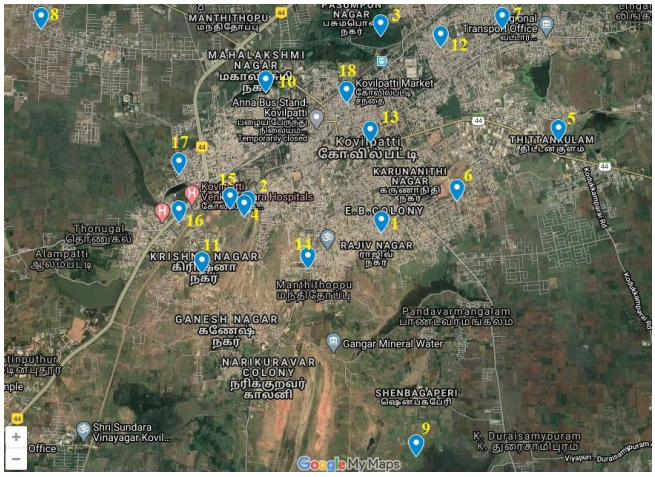

Fig 1. Study area and sampling locations

B. Materials and Methods

Good Each and every stage in the project will be explained clearly through flow chart (Fig 2).

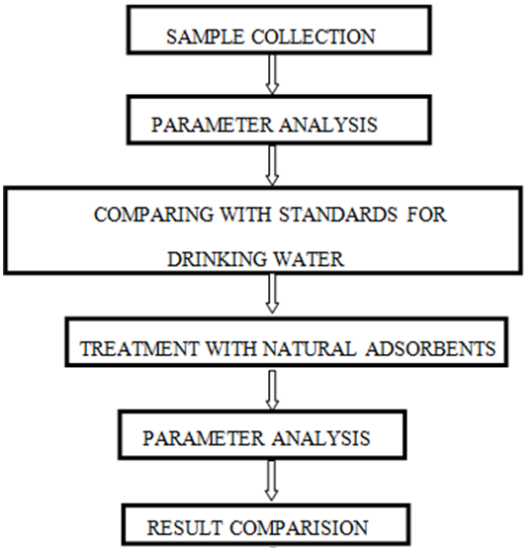

Fig 2. Flow Chart of the present work

Based on various parameters like geological condition, industrial area, location of natural water body we had selected 18 stations in Kovilpatti. The detail of selection of station points were listed (Table 1). The samples were collected in HDPE bottles which are pre-treated with Nitric acid. The samples have been collected from the bore wells, stored in a place to avoid the direct fall of sunlight on the samples (i.e. ice box, 4ºC). Physical parameters like pH, TDS, Turbidity, and EC were determined using probes in our laboratory and chemical parameters like chloride, fluoride, iron, hardness were found from titrations [8, 9]. Experimentation were carried out with and without adding natural adsorbents by varying dosage ,time duration ,method of mixing the adsorbent. The samples were collected in HDPE bottles which are pre-treated with Nitric acid. The samples have been collected from the bore wells, stored in a place to avoid the direct fall of sunlight on the samples (i.e. ice box, 4ºC). Physical parameters like pH, TDS, Turbidity, and EC were determined using probes in our laboratory and chemical parameters like chloride, fluoride, iron, hardness were found from titrations [8, 9]. Experimentation were carried out with and without adding natural adsorbents by varying dosage ,time duration ,method of mixing the adsorbent.

C. Treatment Using Neem Leaves

The treatment of Neem leaves have the following steps.

(i). Neem leaves were collected **(**Fig 3**)** and dried under the sunlight for about two days and then crushed manually.

(ii). Crushed leaves are made to pass through 90 micron sieve. The crushed leaves which are passed through 90 micron sieve are used as the absorbent to treat the water sample.

(iii). The bio mass is prepared by the 0.5N sodium hydroxide by allowing it to pass through the crushed Azadirachta Indica leaves placed in whattman filter paper. The retained mass in the filter paper is allowed to pass the distilled water. This is process is used to reduce the effect of the colour of the leaves on the results.

Fig 3. Neem Leaves

(iv). The biomass (adsorbent) is added to the water samples and keeping the time constant for 45 minutes and varying the dosages as 0.2 grams and 0.4 grams. After the settling time of 1hr, then the samples were filtered using the whattman filter paper and the filtered sample is used for the parameter analysis in the laboratory [10].

III. RESULTS AND DISCUSSION

A. Drinking Water Quality Parameters

The Experimental results and minimum, maximum values of observed parameters are given in Table 1. From the table, the pH of Kovilpatti region, most of the samples fall within the standard limits of pH. Sample name Kamarajar nagar have the high value of pH. The main sources for elevated TDS levels are human sources and urban runoff. Low levels of TDS causes the water to taste water which makes the water unfit for drinking [11]. From the table shows the levels of TDS in the study area.

According to the standards, the value of TDS should not exceed 1000 mg/l, but the stations Puthukramam and Chenbaga nagar have exceeded the standard limits of TDS. The electrical conductivity of water is a measure of the capacity of the water to carry electric current.

It is measured in milli Siemens/m. A higher conductivity show more amount of chemical dissolved in water and lower values of conductivity affects the chloride content of a water sample [11]. From the table shows the electrical conductivity of the samples in the study area. High levels of chlorides make the water salty in taste and it causes a number of health hazards [11]. From the table most of the samples have exceeded the standard limits of chloride (250 mg/l) [12]. From the table, most of the stations fall within the standard limits of Iron.

Table1. Experimental results and minimum, maximum values of observed parameters

S No	Station Name	Latitude	Longitude	pH	TDS	EC	Cl	Fe	F
1	Rajiv nagar	9°09'46.2"N	77°52'23.1"E	7.9	1160	2516	2837	0.00029	2.24
2	Veeravanchinagar	9°09'54.4"N	77°51'27.2"E	8.2	158	400	322	0.00075	1.92
3	Moopanpatti	9°11'07.3"N	77°52'22.7"E	8.1	1820	3497	6028	0.00058	0.44
4	Srinivasa nagar	9°09'52.7"N	77°51'25.8"E	7.6	1360	1764	2998	0.00043	1.02
5	Thitankulam	9°10'23.9"N	77°53'37.1"E	7.9	402	1088	858	0.00072	2.6
6	SS nagar	9°09'59.1"N	77°52'54.6"E	7.7	1800	3367	4170	0.00057	0.56
7	Muthu nagar	9°11'10.4"N	77°53'13.6"E	8.2	242	624	620	0.00044	0.46
8	Subhanagar	9°11'10.4"N	77°50'01.4"E	7.6	721	1726	1357	0.00072	1.3
9	Shenbanagar	9°08'13.7"N	77°52'37.4"E	7.8	2080	8601	4326	0.00058	0.42
10	Gandhi nagar	9°10'44.1"N	77°51'34.9"E	8.1	160	427	415	0.00043	0.56
11	Krishna nagar	9°09'29.5"N	77°51'08.2"E	7.9	683	1531	1206	0.00043	2.4
12	Puthugramam	9°11'02.4"N	77°52'47.7"E	7.5	2370	4308	5532	0.00057	3.06
13	Tholirpettai	9°10'23.5"N	77°52'18.4"E	8	319	813	553	0.00043	1.68
14	Annaiterasanagar	9°09'31.0"N	77°51'52.7"E	8.3	742	1742	1773	0.00058	0.84
15	Lakshmi mills	9°09'55.9"N	77°51'20.1"E	7.8	878	3601	2021	0.00058	1.42
16	Kamarajarnagar	9°09'50.7"N	77°50'58.4"E	8.7	520	1360	1246	0.0044	0.36
17	Maniachi	9°10'10.4"N	77°50'58.4"E	7.9	660	1633	1299	0.0014	2.1
18	Market	9 10' 40.43"	77 52' 8.39"	7.4	1140	2348	2168	0.00086	2.82
			Minimum	7.4	158	400	322	0.0003	0.36
			Maximum	8.7	2370	8601	6028	0.0044	3.06
			Average	7.9	956	2297	2207	0.0008	1.5
			BIS (2012) permissible limit [12]	6.5 -8.5	1000	1500	250	1	1.5

Fluoride in water causes health issues such as dental fluorosis, skeletal fluorosis etc. When Fluoride levels exceed in water treatment is required. The major health issue caused by Fluoride is the dental cavity [6]. A level of Fluoride in water is analyzed by spectrophotometer. The results are computed and expressed in mg/L. From the table, the fluoride concentration are present in most of the samples with exceeds the standard limits. These higher fluoride samples must apply the water treatment before it's for the drinking consumption. In present study the samples Rajiv nagar, Thitankulam, Puthukramam, Thozhirpettai, market are selected for the removal of fluoride using the Neem leaves adsorbent.

B. Results of Treatment with Neem leaves

The selected samples were treated with natural adsorbent and the results of this treatment shows the fluoride concentration have been reduced after the treatment.

The reduced concentration of pH, TDS and Fluoride are given in Table 2. Comparison results of the fluoride of before and after treatment as shown in the fig.4. The treatment of 5 samples with the Neem leaves, when 19% of the Fluoride removal efficiency was obtained in 0.02g of the adsorbent used. While 52% of the removal efficiency of Fluoride was obtained when 0.04 g of adsorbent were used. Especially Pudhukramam samples have the 87% of the removal efficiency at 0.04g adsorbent were used. The comparison between the removal efficiency of 0.02g and 0.04g are shown in fig.5 and Table 3. Sample collected in Pudhukramam gives the maximum fluoride removal efficiency of 87% as 0.04g adsorbent is used.

IV. CONCLUSION

The present study in the analysis of groundwater samples in the Kovilpatti region reveals that the samples were polluted with fluoride and chloride. So, the polluted groundwater samples needed to the water treatment before it consumption of drinking.

The natural adsorbent of Neem leaves used to treat the groundwater in present study. As per the expectations, the Neem leaves are good for the water treatment and it gives higher removal efficiency. When 0.02g and 0.04g of adsorbent were added to the polluted groundwater, the obtained removal efficiency is 19% and 52% respectively. Especially, Pudhukramam groundwater samples have the 87% of the removal efficiency at 0.04g adsorbent were used.

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Table 2. Results of after treatment with Neem (Azadirachta Indica) Leaves

S.No	Station	pH			TDS			Fluoride (F^-)		
		Before	0.02g	0.04g	Before	0.02g	0.04g	Before	0.02g	0.04g
1	Rajiv nagar	7.9	7.2	7	1160	897	658	2.2	2.1	1.4
2	Thitankulam	7.9	7.8	7.7	402	393	317	2.6	2.4	1.2
3	Pudhukramam	7.5	7.3	7.2	2370	2090	1655	3.1	1.3	0.4
4	Thozhirpettai	8	7.8	7.7	319	312	297	1.7	1.5	1.2
5	Market	7.5	7.3	7.2	1140	1100	833	2.8	2.4	1.3

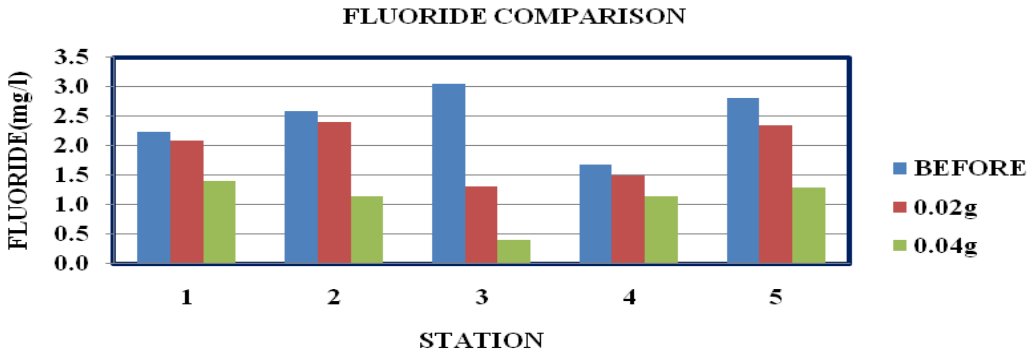

Fig 4. Comparison of Fluoride after treatment with Neem Leaves

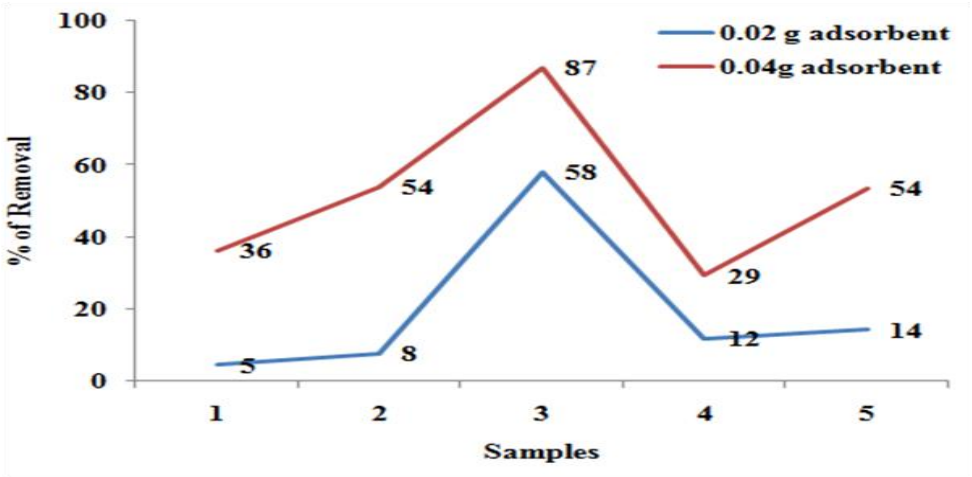

Fig 5. Comparison of removal Efficiency

Table 3. Comparison of removal efficiency of Fluoride

S.No	Station	Fluoride (F^-)				
		BEFORE	0.02g	% of removal	0.04g	% of removal
1	Rajiv nagar	2.2	2.1	5	1.4	36
2	Thitankulam	2.6	2.4	8	1.2	54
3	Pudhukramam	3.1	1.3	58	0.4	87
4	Thozhirpettai	1.7	1.5	12	1.2	29
5	Market	2.8	2.4	14	1.3	54
			Average	19%	Average	52%

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