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Research Article

Removal of Hardness (Ca^{2+}, Mg^{2+}) and Alkalinity from Ground Water by Low Cost Adsorbent using *Phyllanthus emblica* Wood

D. Kannan*, N. Mani

Department of Chemistry A. V. V. M. Sri Pushpam College, Poondi, Thanjavur, India

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ABSTRACT

The main problem of the locality is the drinking water certain health problems are associated with people living in hills that are because of the presence of excess of ions and other impurities. The present study was conducted to analyze the some physicochemical parameters and removal of ions using *Phyllanthus emblica* adsorbent for purification of ground water for drinking purpose. In present study various dose of *Phyllanthus emblica* carbon are taken and checked for the efficiency dose on ground water. After treatment of water sample with *Phyllanthus emblica carbon* were analyzed for different parameters like TDS, Mg^{2+}, Ca^{2+}, Alkalinity, electrical conductivity all parameters were reduced with increased dose of *Phyllanthus emblica* carbon.

Key words: Ground water treatment, Low cost activated carbon, Removal of hardness and *Phyllanthus emblica*.

1. INTRODUCTION

Ground water is polluted due to industrial effluent and municipal waste in water bodies. In rural and undeveloped countries people living in extreme poverty are presently drinking highly turbid and contaminated water. A variety of methods have seen developed for the removal of toxic organic and inorganic constituents from water and waste water. The methods are adsorption, chemical precipitation, reverse osmosis membrane filtration, ion exchange and coagulation.

The *Moringa oleifera* seeds acts as a natural Coagulant, Flocculants, adsorbent for the treatment of ground water. It reduces the total hardness, turbidity, acidity, alkalinity, chloride. It also acts as a naturally occurring antimicrobial active agent the micro organisms which are present in the drinking water and decrease the number of bacteria[1].

The analysis of the water quality parameters of drinking water from lake and silver cascade water falls in kodaikanal was analyzed for pH , turbidity, Total hardness, Total Dissolved Oxygen, sulphate, fluoride, iron, nitrate, etc., values are well within the permissible, limits after the treatment with plant extract. In the present study a seed of V. Zizaniodes was found to be most effective as compared to *T. Chebula*[2] .

Waste plastic as a synthetic resin to remove hardness in ground water, the designed hardness removal system is expecting to be suitable for ground water household use. Further study should be conducted to investigate the recovery efficiency of made resin as well as be examined other polystyrene plastics to remove hardness in water[3]. Increasing dosage of *Moringa oleifera*, increases the hardness removal efficiency. The amount of dosage of *Moringa oleifera* required in a particular water sample depends on the number of hardness causing species present in water. *Moringa oleifera* as a coagulant is observed more effective for lower initial hardness and the removal efficiency decreases with increasing the initial hardness[4].

Removal of nitrate ion from ground water using chitosan as an adsorbent, the use of chitosan in powder form, to treat water, showed positive results. Nitrate removal was significant but

Corresponding Author:
D. Kannan, Email: kannanchemist1989@gmail.com

chitosan powder rendered the water turbid with may be aesthetically objectionable. It showed better result in the lowest concentration used i.e. 0.5g/250 ml sample[5].

Study on effective and cheap adsorbents for the removal of fluoride from the water. Batch adsorption studies are demonstrated that the adsorbents have the significant capacity to absorb the fluoride from water[6].

Characterization of the natural zeolite from sakhaptinsk deposit was made and the efficiency of those in the removal of iron, manganese, calcium from underground water has been investigated[7].

Softening of hard water by removing Ca^{2+} and Mg^{2+} cation was studied using natural and alkali modified pumices as adsorbents. Increasing the mass of adsorbent, the contact time (or) the initial ions concentration led to an increase of cations removal. The studied pumice adsorbent showed a higher selectivity for calcium adsorption if compared to magnesium[8].

The adsorption of metal ion (Mg^{2+} and Ca^{2+}) on PAA hydro gel bead was successfully achieved and confirmed for removal of Mg^{2+} and Ca^{2+} ion from aqueous solution was studied by using the batch process under influence of different parameters. The maximum adsorption capacity values of metal ion were identified at pH 6.3. The data of equilibrium was well described by both Longmuir and freundlich models. Application of the method for natural tap water – softening and treatment was successfully accomplished[9].

2. MATERIALS AND METHODS

2.1 Study area

The ground water sample were collected Thiruvidaimaruthur from Thanjavur District.

2.2 Methodology

The activated carbon was prepared by air dried *Phyllanthus emblica* wood powder with concentrated sulphuric acid in a weight ratio 1:1. The resulting black product was kept in a furnace maintained at 160^0 C for shows followed by washing with distilled water until it become free from excess acid and dried at 110^0 C for a period of 2 hours. The carbon product obtained from *Phyllanthus emblica* wood was grained well to fine powder and the portion retained between 90µ to 53µ sieves was used in all the adsorption experiments. This carbon is designated as *Phyllanthus emblica* wood carbon (PEWC).

The ground water for study purpose was collected from Thanjavur District. The effect of adsorbent dosage was studied by varying the carbon dose mixed with ground water. The various doses consisting of the adsorbent respectively mixed with ground water sample and kept on the magnetic stirrer for 120 minutes at 1280 rpm.

The percentage of adsorption for different doses was determined by keeping all other factor constant. After the treated water was used for test, the water quality parameters were checked for physicochemical parameters as per Indian standard methods (table-1) before and after treatment.

2.3 Adsorption efficiency

The efficiency dose of *Phyllanthus emblica* adsorbent was determined using following formula:

Adsorption Efficiency (Q_e) = Initial concentration ions – Final Concentration ions × 1000 / mg in Adsorbent.

3. RESULTS AND DISCUSSION

For ground water, following drinking water quality parameters were analyzed after the treatment of various doses of *Phyllanthus emblica* wood carbon.

3.1 Total dissolved solid

The initial total dissolved solid observed was 879 mg/l for ground water which was beyond the limits of BIS. It was observed that the use of *Phyllanthus emblica* wood carbon showed decrease in TDS of ground water with increased dose at 1 g/l to 7 g/l, (Table-2), (Fig-1).

3.2 Electrical conductivity

The initial electrical conductivity observed was 1.88 mS / cm in ground water. It was observed that the use of *Phyllanthus emblica* wood carbon showed decrease in electrical conductivity (1.88 – 1.26 mS/cm) of ground water with increased dose at 1 g/l to 7 g/l respectively, (Table-2), (Fig-2).

3.3 Calcium (Ca^{2+})

The initial calcium (Ca^{2+}) observed was 92.17 mg/l in ground water which was beyond the limit of BIS. It was observed that the use of *Phyllanthus emblica* wood carbon showed decrease in calcium of ground water with increased dose at 1 g/l to 7 g/l, (Table-2), (Fig-3).

After treatment the concentration of calcium ion is 26.05 mg/l and within the limit. The permissible limit for calcium concentration is 75 mg/l according to BIS.

3.4 Magnesium (Mg^{2+})

Magnesium during the present research work was observed to be 68.05 mg/l for ground water sample. Treatment of *Phyllanthus emblica* wood carbon was given to ground water samples in different dose.

During the analysis, it was observed that after treatment with *Phyllanthus emblica* wood carbon; Mg^{2+} was decreased at 1 g/l to 7 g/l dose, (Table-2), (Fig-4). After treatment the magnesium concentration is 20.05 mg/l. The recommended limit for Mg^{2+} concentration is 30 mg/l according to BIS.

3.5 Total alkalinity

The initial concentration of total alkalinity observed was 228.03 mg/l in ground water which was beyond the limit of BIS. It was observed that the use of *Phyllanthus emblica* wood carbon showed decrease in total alkalinity of ground water with increased dose at 1 g/l to 7 g/l, (Table-2), (Fig-5)

After treatment the concentration of total alkalinity is 23.29 mg/l. The permissible limit of total alkalinity is 200 mg/l. according to BIS.

Adsorption efficiency of calcium, magnesium, alkalinity are given in the table-3, before and after treatment of *Phyllanthus emblica* wood carbon and its concentration variation of calcium, magnesium, alkalinity are shown in the figure-6.

Table 1: Methods used for chemical study of ground water

Parameters	Methods	Reference
Calcium	EDTA- Titrimetric method	IS:3025(Part 40)
Magnesium	EDTA- Titrimetric method	IS:3025(Part 46)
Total Alkalinity	Indicator method	IS:3025(Part 23)
Total Dissolved Solids	Gravimetric method	IS:3025(Part 16)
Electrical Conductance	Conduct metric method	IS:3025-1964

Table 2: Parameter studied before and after treatment of groundwater with various dose of *Phyllanthus emblica* wood carbon

Parameters	Before Treatment	After treatment of water at various dose of *Phyllanthus emblica* wood carbon							BIS Standards
	0 g/l	1 g/l	2 g/l	3 g/l	4 g/l	5 g/l	6 g/l	7 g/l	
TDS	879	684	654	594	563	543	534	535	500 mg/l
Electrical Conductivity	1.88	1.63	1.54	1.41	1.33	1.28	1.26	1.26	-
Calcium	92.17	67.13	54.10	40.07	28.05	26.05	26.05	26.05	75 mg/l
Magnesium	68.05	49.21	37.67	29.16	24.30	20.65	20.65	20.65	30 mg/l
Total Alkalinity	228.03	164.28	111.56	68.65	34.32	23.29	23.29	23.29	200 mg/l

Table 3: Removal efficiency of Calcium, Magnesium and Total Alkalinity

Parameters	C_0 (mg/l)	C_e (mg/l)	Q_e (mg/g)	Percentage of removal	Temperature
Calcium (mg/l)	92.17	26.05	13.22	71.7	302.6 K
Magnesium (mg/l)	68.05	20.65	9.48	69.65	
Total Alkalinity (mg/l)	228.03	23.29	40.94	89.78	

Where,

C_0 =Initial concentration of ions,

Ce = Equilibrium concentration of ions,

Q_e = Adsorption efficiency.

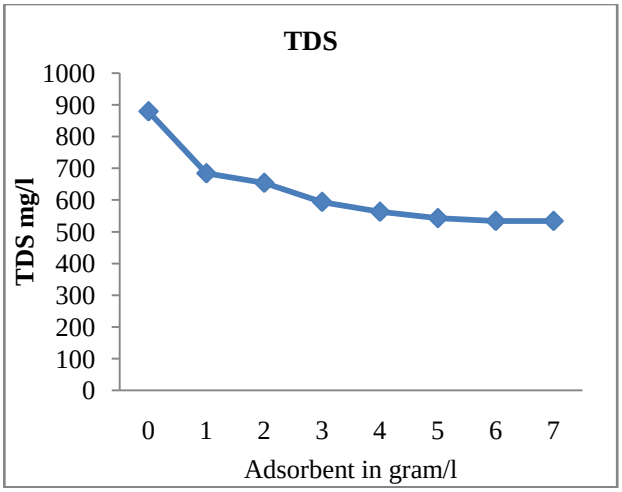

Fig. 1: TDS of ground water before and after treatment of *PEWC*

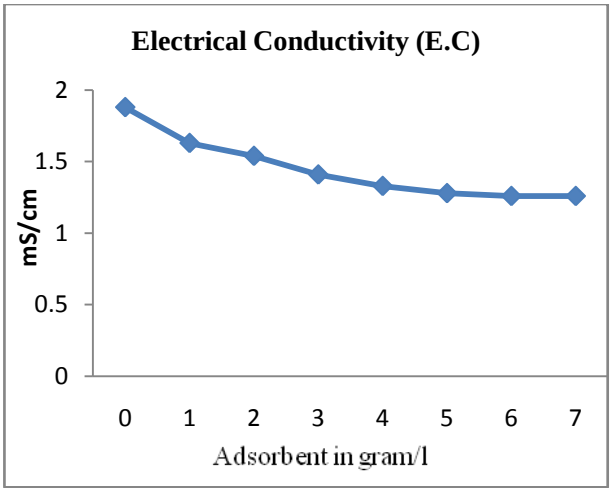

Fig. 2: E.C. of ground water before and after treatment of *PEWC*

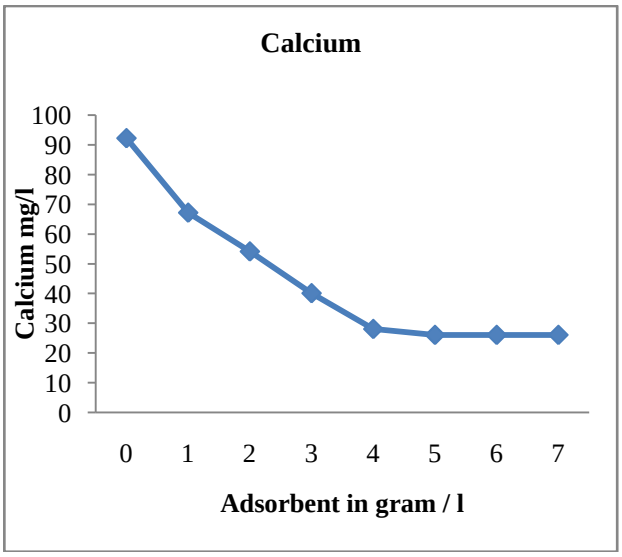

Fig 3: Calcium of ground water before and after treatment of *PEWC*

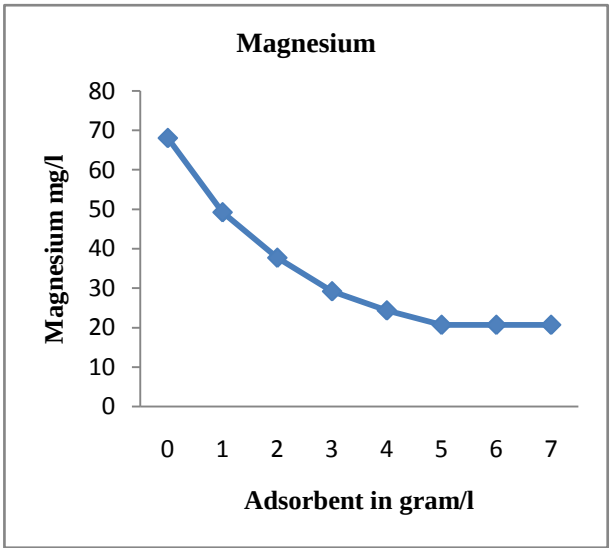

Fig. 4: Magnesium of ground water before and after treatment of *PEWC*

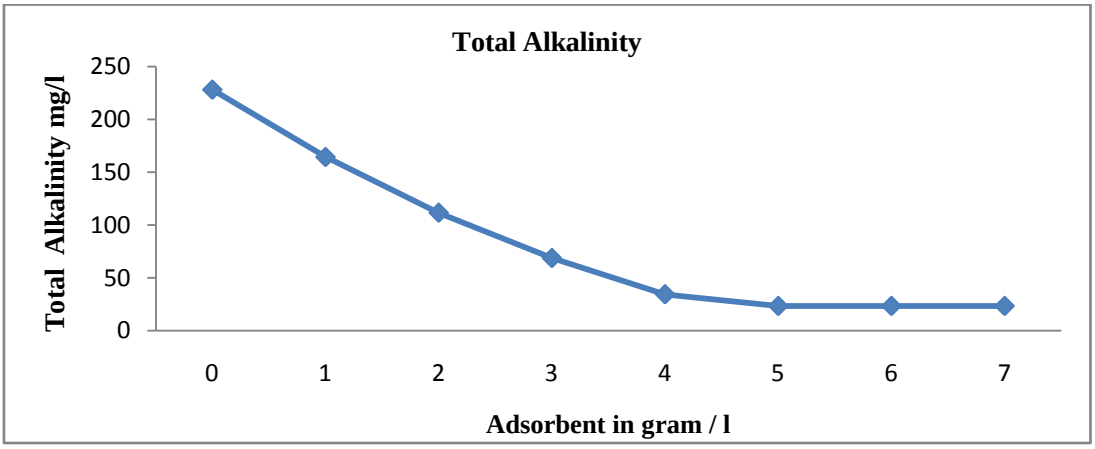

Fig 5: Total Alkalinity of ground water before and after treatment of *PEWC*

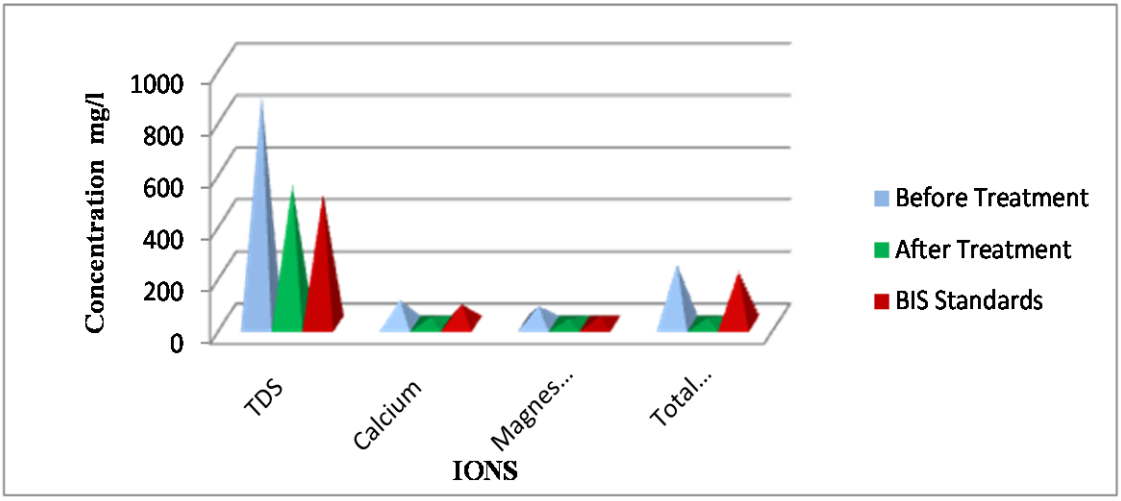

Fig. 6: concentration variation of ground water before and after treatment of *PEWC*

4. CONCLUSION

The ground water sample collected and analyzed for various physicochemical parameters of Thiruvidaimaruthur of Thanjavur District. The results of physicochemical parameters like TDS, EC, Total Hardness (Ca^{2+}, Mg^{2+}) and Total Alkalinity are more than desirable limit of BIS drinking water quality guideline. So the human beings of that the region suffering with various diseases like gastrointestinal irritations and skin irritation.

The objective of this study is to clarify the mechanism of simultaneous removal of hardness (Ca^{2+}, Mg^{2+}) and total alkalinity in ground water for drinking purpose by using *Phyllanthus emblica* wood carbon.

Phyllanthus emblica wood carbon is not giving toxic effect. It is cheaper method of water treatment. The *Phyllanthus emblica* wood carbon can be used in the rural areas where no facilities are available for the drinking water treatment. In present study various dose of *Phyllanthus emblica* wood carbon are taken and checked for the efficiency dose on ground water. After treatment of water sample with *Phyllanthus emblica* wood carbon were analyzed for different parameters like TDS, electrical conductivity, calcium (71.7 %), Magnesium (69.6 %) and total alkalinity (89.7 %) were reduced with increased dose of *Phyllanthus emblica* wood carbon.

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