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# A Study on Biosorbents for the Removal of Chloride Ion from Water

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**Abstract:- presence of pollutants in aqueous solution particularly from hazardous heavy metals and metalloids is an important environmental and social problem. The chlorides are one of the serious groundwater contaminants in rural areas. The chlorides are regulated in drinking water quality primarily because excess amounts can cause disease. Chloride in both its gaseous and liquid form can be irritating to the eyes, respiratory tract and skin due to its alkaline nature. Biosorption is one of the biological treatments that has emerged as a new technology for the removal and recovery of metal ions from aqueous solutions which is more environmentally friendly. In this study biosorption were used with the intention to remove heavy metals such as copper, zinc, chlorides and mercury ions from synthetic (distilled) water. Chloride analysis shows that presence of the heavy metal absorption by Solids and flowers.**

***Keywords:*** *Chlorides, Biosorption's, Kinetic Equilibrium, Isotherm Data and Regeneration.*

## I. INTRODUCTION

Water plays a key role in the world economy and life of humans and animals. Majority (71%) of the Earth's surface is covered by water, but fresh water contains only minority (3%) of the total. But in many developing countries, 90% of all consumption, which either leads to scarcity or affects the human population. The concern to protect fresh water bodies for a healthy population is a challenge in recent times. Industrialization to a larger degree is responsible for the contamination of environment especially water where lakes and rivers are overwhelmed with a large number of toxic substances. Heavy metals are reaching hazardous levels when compared with the other toxic substances Biosorption has emerged as an attractive option over conventional methods for the removal of heavy metal ions from effluents discharged from various industries which ultimately reach and pollute fresh water bodies.

## II. LITERATURE REVIEW

In **Muthuramanet**. et. al., the Agricultural, Domestic, Industrial and anthropogenic activities are the main contaminants of groundwater. In this studies Sugarcane Bagasse from agricultural waste have been selected as solid phase extractor for removal of total iron. The highest percentage removal of total iron was observed at Sugarcane Bagasse (93%).

Maximum removal is at pH 5 and removal efficiency increases with lower initial metal concentration and higher adsorbent dose.

According to **Balaji** et al., Groundwater is mainly contaminated by anthropogenic activities like such as agricultural, domestic and industrial. The tests are conducted at West Mugapair, Chennai, where concentration of iron in the groundwater is relatively too high. In this study Coconut coir (COC) from agricultural waste have been selected as solid phase extractor for removal of total iron. These materials exhibit remarkable binding characteristics for removal of total iron. The highest percentage removal of total iron was observed at Coconut coir (96%). The Bio adsorbents cover small plants, shrubs and trees etc. Low-cost materials prepared from Bio-wastes such as grass, plants, shrubs, fruits and vegetable peels, nuts, shells, pulps, stones, barks, roots, leaves, fruit wastes.

➢ *Various Bio Adsorbent and their Biosorption Capacity:*

| S.no | Adsorbent | chlorides removal (%) | pH | Contact time (min) | Particle size (µm) | Adsorbent dosage (g) | Temperature (°C) | Chlorides Concentration (mg/L) | References |
|---|---|---|---|---|---|---|---|---|---|
| 1. | Biochar | >80 | 6 | 180 | _ | 0.25 | 24.85 | 8 mg/L | Idrees et al., 2018 |
| 2. | Rice husk ash | 100 | 3 | 100 | 300 | 0.5 | 30 | 3.8mg/L | Adekola et al., 2016 |
| 3. | Sunflower seed shell | 81.6 | 8 | 120 | _ | 0.15 | _ | _ | Feizi and Jalali, 2015 |
| 4. | Peanut husk | 100 | 6 | 180 | - | 5 | 25 | 20mg/L | Abdelfattah et al, 2016 |
| 5. | Potato peel | 79.8 | 7 | 120 | - | 0.15 | - | - | Feizi and Jalali, 2015 |
| 6. | Canola flower | 81.8 | 8 | 200 | - | 0.15 | - | - | Feizi and Jalali, 2015 |
| 7. | Walnut shell | 96.5 | 8 | 200 | - | 0.15 | - | - | Feizi and Jalali, 2015 |
| 8. | chitosan | 84.5 | 5 | 120 | 0.158 | 0.8 | 30 | 20mg/L | Abdeen et al., 2015 |
| 9. | banana peel | >80 | 6 | 60 | - | 4 | 25 | 10mg/L | Ali and Saeed,2015 |

➢ *Work Progress*

- *Preparation of Bio-Adsorbents:*

The process of preparation of bio-adsorbents is a simple procedure which involves collection of bio-degradable waste. The bio-degradable wastes which we are collected are rape straw, rice husk, parthenium, sawdust

and egg shell. The waste material is thoroughly cleaned and sun dried. The dry material then grinded into powdered with the help of an electric grinder mixer. The powdered bio-adsorbents are stored in air tight plastic containers.


Fig 1 Solid & Flower Biosorbents

➢ *Procedure for Addition of Bio-Adsorbents in Water*

The powdered biosorbent materials are to be added to the contaminated water in order to perform the chloride and the hardness test. For the chloride test, a volumetric flask of 1 liter capacity is taken and then made a solution with the help of sodium chloride i.e.., the concentration of chloride is 1mg/litre. For the hardness test, tap water is collected from the waste water engineering laboratory, gudlavalleru engineering college, gudlavalleru which is located in Krishna district at Andhra Pradesh. The solution is divided into six equal parts of containing 150ml in each beaker and then the bio-adsorbent material is added in the form of 1gm, 2gm, 4gm, 6gm, 8gm and 10gm in six beakers respectively The beakers then placed on heavy rotary shaker for a period of one and half hour the solution is then filtered with the help of filter papers into a conical flask.A heavy rotary shaker is used for the purpose of uniform mixing, the unit is prepared with heavy mild steel sections it has adjustable speed limit. Filtration is a process of separating the suspended particles from the solution with the help of filter paper in order to obtain suspended free particle solution.

➢ *Procedure for Chloride Removal*

- Chloride contaminated water with biosorbent material is placed on heavy rotary shaker for a period of one hour.
- After mixing, the solution is filtered with the help of filter paper.
- The filtered solution is then taken into a separate beaker.
- Take 20ml of sample in a conical flask.
- Add 1ml of potassium chromate into the conical flask.
- Fill the burette with the silver nitrate solution.
- Now titrate the sample with the silver nitrate.
- Titrate until the yellow colour changes into brackish red colour.
- Repeat the above process until two consecutive readings obtained.

➢ *Analysis Comparision of Solid and Flower Biosorbents for Removal of Chlorides*

Each biosorbent has its unique percentages in removal of chloride of contaminated water. Some biosorbents have high capacity in removal of chlorides whereas some have low capacity. The percentage removal of chlorides of every biosorbent are compared as shown in Fig. 2(a) and 2(b).

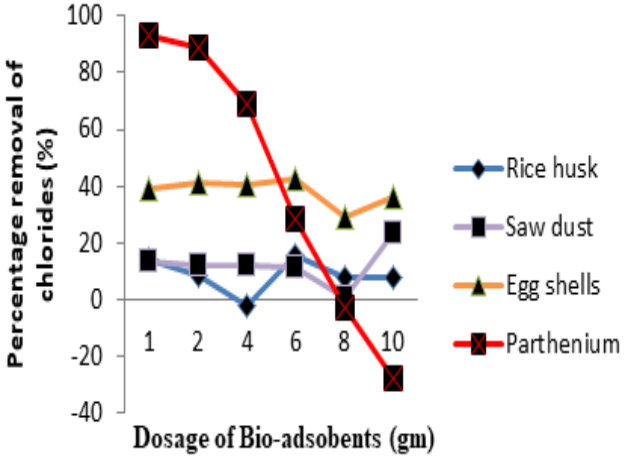


Fig 2 (a) Comparison of Chloride Removal for Solid Bio Adsorbents

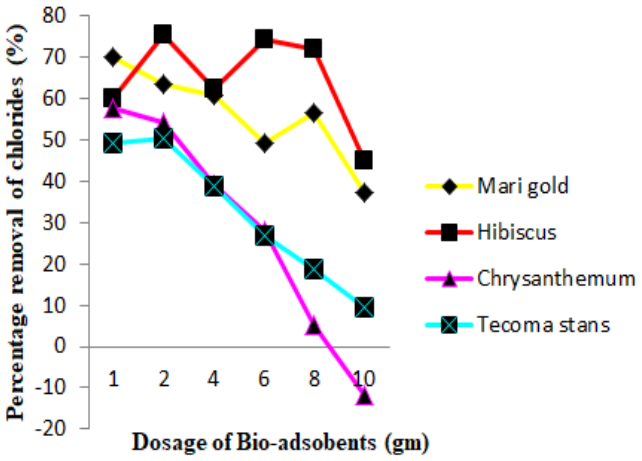


Fig 2 (b) Comparison of Chloride Removal for Flower Bio Adsorbents

➢ *Optimization of Different Parameters in Chloride Removal from Water:*

Parthenium shows the best result in removal of chlorides as compared with the other selected biosorbents. So, it is necessary to find out the optimum concentration of biosorbents, optimum pH, optimum temperature, optimum time and agitation speed for removal of chloride from contaminated water.

- *Optimization in Ph*

Determination of the optimum pH for the reaction was therefore taken up as the primary procedure. By keeping the contact time and the concentration of the test solution constant, the reaction was carried out at different pH values as depicted in FIG. Through this study, it was observed that the optimum pH at which maximum biosorption occurred

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was in the range of 5.5- 7. This is not only helpful in easy monitoring of the further process, but cost economic as well because there is no need of additional pH regulation system.

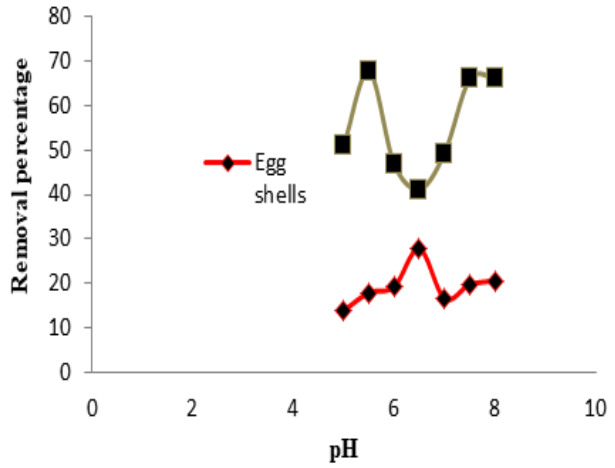


Fig 3 Optimization in pH for chloride removal

- *Optimization in Contact Time*

In the methodology adopted for the experiment, the contact time was kept at 60 minutes. However, as the rate of reaction is time dependent, an experiment was carried out in order to evaluate the reaction rate at variable contact periods as depicted in Fig. The other parameters were maintained constant, while varying the contact time between the biomass and the test solution. It is observed that there is incrimination with the increase in contact time up to 80 minutes and then it became constant.

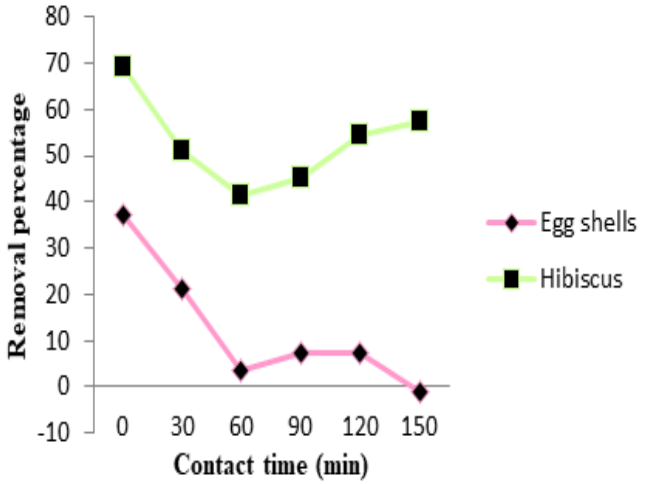


Fig 4 Optimization in Contact Time for Chloride Removal

- *Optimization in Rotation Speed*

The rotation speed is also one of the very important factors affecting the chloride removal in contaminated water. The rotation speed increases from 30 rpm to 120rpm and measured the chloride removal percentages. From Fig. 5 it is observed that the optimum rotation speed for the chloride removal is 90 rpm for Egg shells and 120 rpm for Hibiscus.

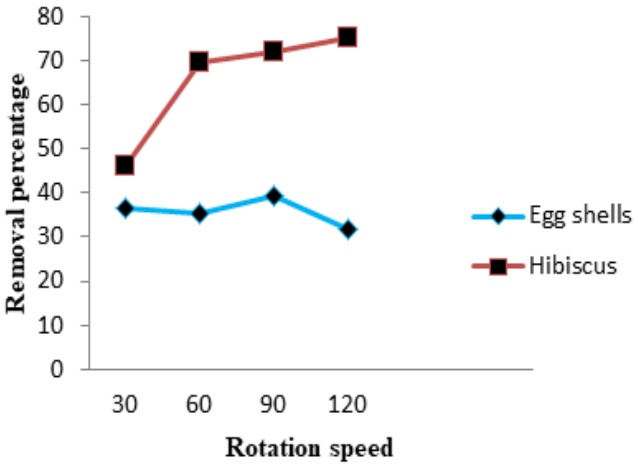


Fig 5 Optimization in Rotation Speed for Chloride

- *Optimization in Bio-Adsorbent Dosage*

The amount of biosorbent dosage plays an important role in the removal of chlorides present in the water. In this dosage of bio-adsorbent is calculated to accurate amount at which the chlorides in water are removed at the best. The addition of Egg shells from 3.7 gm to 4.3 gm and Hibiscus from 1.1gm to 1.6 gm biosorbents are done in chloride contaminated water.

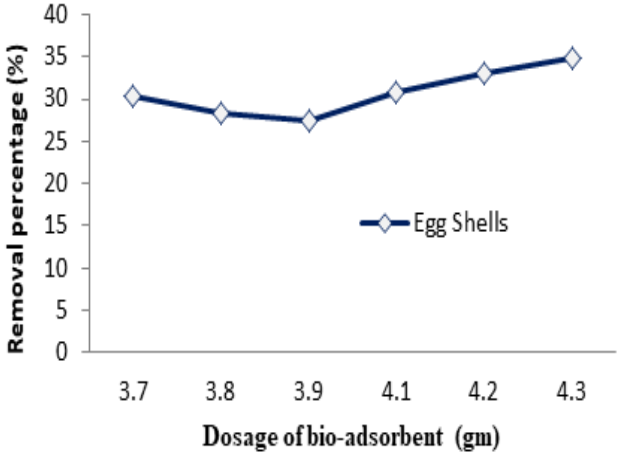


Fig 6 (a) Optimization in Bio-Adsorbent Dosage for Egg Shells

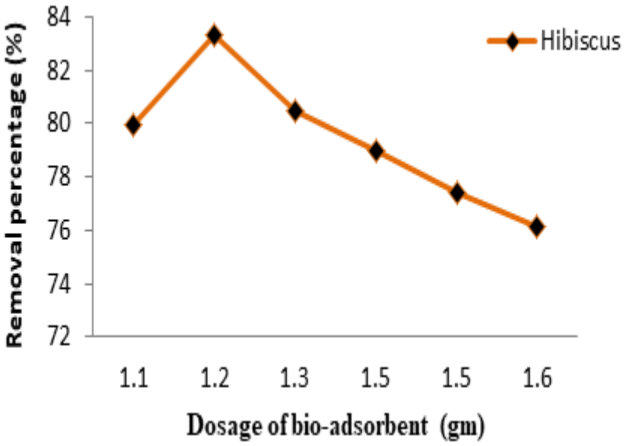


Fig 6 (b) Optimization in Bio-Adsorbent Dosage for Hibiscus

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- *Optimization in Temperature*

The optimization of temperature is carried out between 30-50 $^0$C using a thermostatically controlled incubator. The variations of adsorptions efficiency of chloride on parthenium biosorbent as function of solution temperatures. It was observed that the temperature does not have significant influence on the biosorption capacity in the studied range.

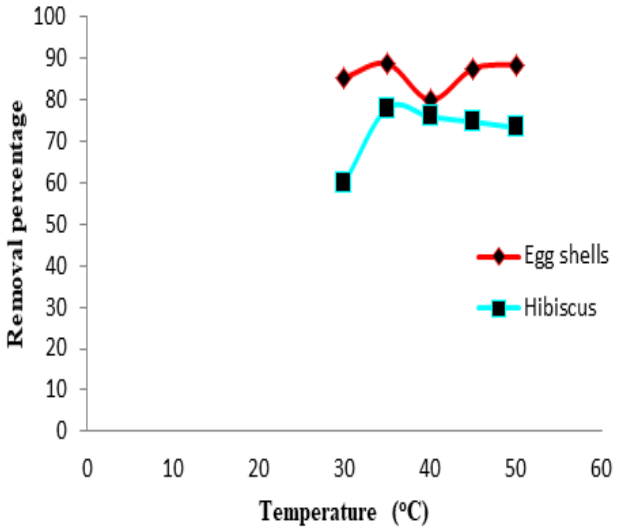


Fig 7 Optimization in Temperature for Chloride Removal

Fig.it is observed that within increase in temperature from 30$^0$C to 50$^0$C there is an increase in removal percentage and from 40$^0$C to 45$^0$C there is decrease in removal percentage. The variations may be caused due to the adsorption capacity of the parthenium bio-adsorbent material. Furthermore, studies are to be carried out to understand the relation between the temperature and the bio-adsorbent. From the graph it is to be stated that the optimum temperature will be the room temperature.

➢ *Kinetic Study of Water*

The data obtained from kinetic study were analyzed in accordance with pseudo-first order, pseudo-second order, Elovich and intraparticle diffusion kinetic models to find out the mechanism of adsorption. The corresponding kinetic parameters are listed in Table. Figure represents the adsorption rate curves generated for hardness ions adsorption on Egg Shells & Hibiscus biosorbents. It was observed a rapid uptake of metal ions within the first 50 min and then, the process continues slowly, which was expected due to due to alarger surface area of the adsorbent being available for the adsorption of the Chlorides. The repulsive forces between cations already set and the free ones in solution affect rate of adsorption overtime. In this work, Egg Shells& Hibiscus biomass was used to prepare different biosorbents by physico-chemical modifications in order to use them for removing Chlorides from aqueous solution. In addition, adsorption kinetics was studied to determine the kinetic model (pseudo first order, pseudo Second order).

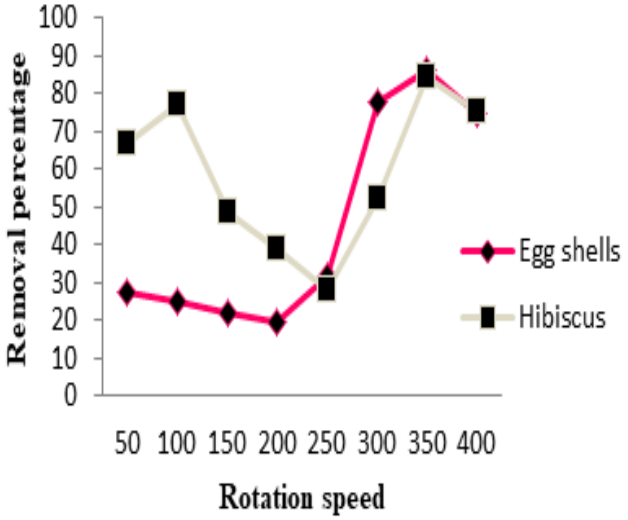


Fig 8 Kinetic Study of Water

➢ *Analysing Different Location of Water*

Now a days, due to over usage of pollutants (Chemicals) in industrial and agricultural sectors Chlorides and other Toxic matters are mixing with water. Which leads to massive water pollution. On consuming this polluted water various water borne deceases are wide spreading among demands on animals effecting their health.

One of the main pollutants in water is Chloride. For removing these chlorides, we are using some Flora and some solid materials which we had collected from different locations. We had collected flowers (Mari gold, Hibiscus, Chrysanthemum, Tacoma stans) from temples and solid materials like Rise husk from rice mills, Saw dust from Timber depot, Egg shells from Restaurant's and Parthenium from Barren lands.

To test and remove the chlorides we had collect the water, from below mentioned locations Vijayawada (Madura Nagar), Gudivada (Bethavolu), Machilipatnam (Hussain palm), Gudlavalleru (Main Road).

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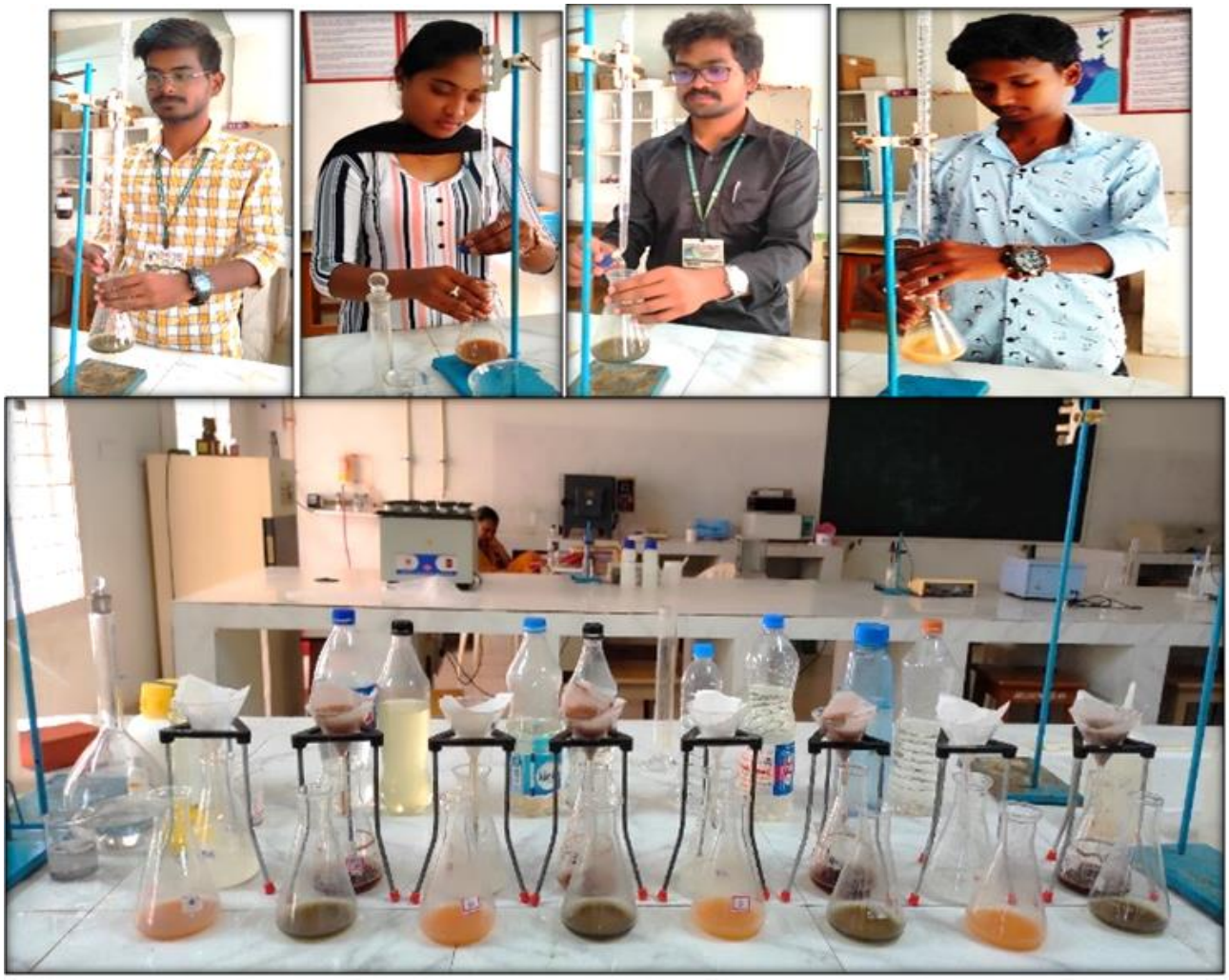

Fig 9 Analysing a Different Location of Waters

Table 1 (a) Removal of Chlorides (%) using Egg Shells

| S. no | Location | Surface Water | | % Removal of chlorides | Ground Water | | % Removal of chlorides |
|---|---|---|---|---|---|---|---|
| | | Initial Chloride's (mg/l) | Final Chloride's (mg/l) | | Initial Chloride's (mg/l) | Final Chloride's (mg/l) | |
| 1. | Vijayawada (Madura Nagar) | 312.757 | 141.48 | 54.76 | 158.86 | 46.72 | 70.60 |
| 2. | Gudivada (Bethavolu) | 193.91 | 163.82 | 18.075 | 188.64 | 49.644 | 73.68 |
| 3. | Gudlavalleru (Main Road) | 732.24 | 188.64 | 73.55 | 446.79 | 196.09 | 56.11 |
| 4. | Machilipatnam (Hussain palm) | 203.50 | 92.65 | 54.47 | 392.18 | 163.82 | 79.74 |

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Table 2 (b) Removal of Chlorides (%) using Hibiscus

| S. no | Location | Surface Water | | % Removal of chlorides | Ground Water | | % Removal of chlorides |
|---|---|---|---|---|---|---|---|
| | | Initial Chloride's (mg/l) | Final Chloride's (mg/l) | | Initial Chloride's (mg/l) | Final Chloride's (mg/l) | |
| 1. | Vijayawada (Madura Nagar) | 312.75 | 92.6 | 70.39 | 158.86 | 62.96 | 60.36 |
| 2. | Gudivada (Bethavolu) | 193.91 | 65.82 | 66.05 | 188.64 | 48.96 | 74.04 |
| 3. | Gudlavalleru (Main Road) | 732.24 | 98.52 | 86.54 | 446.79 | 82.62 | 81.50 |
| 4. | Machilipatnam (Hussain palm) | 203.50 | 64.52 | 68.04 | 392.18 | 72.996 | 81.39 |

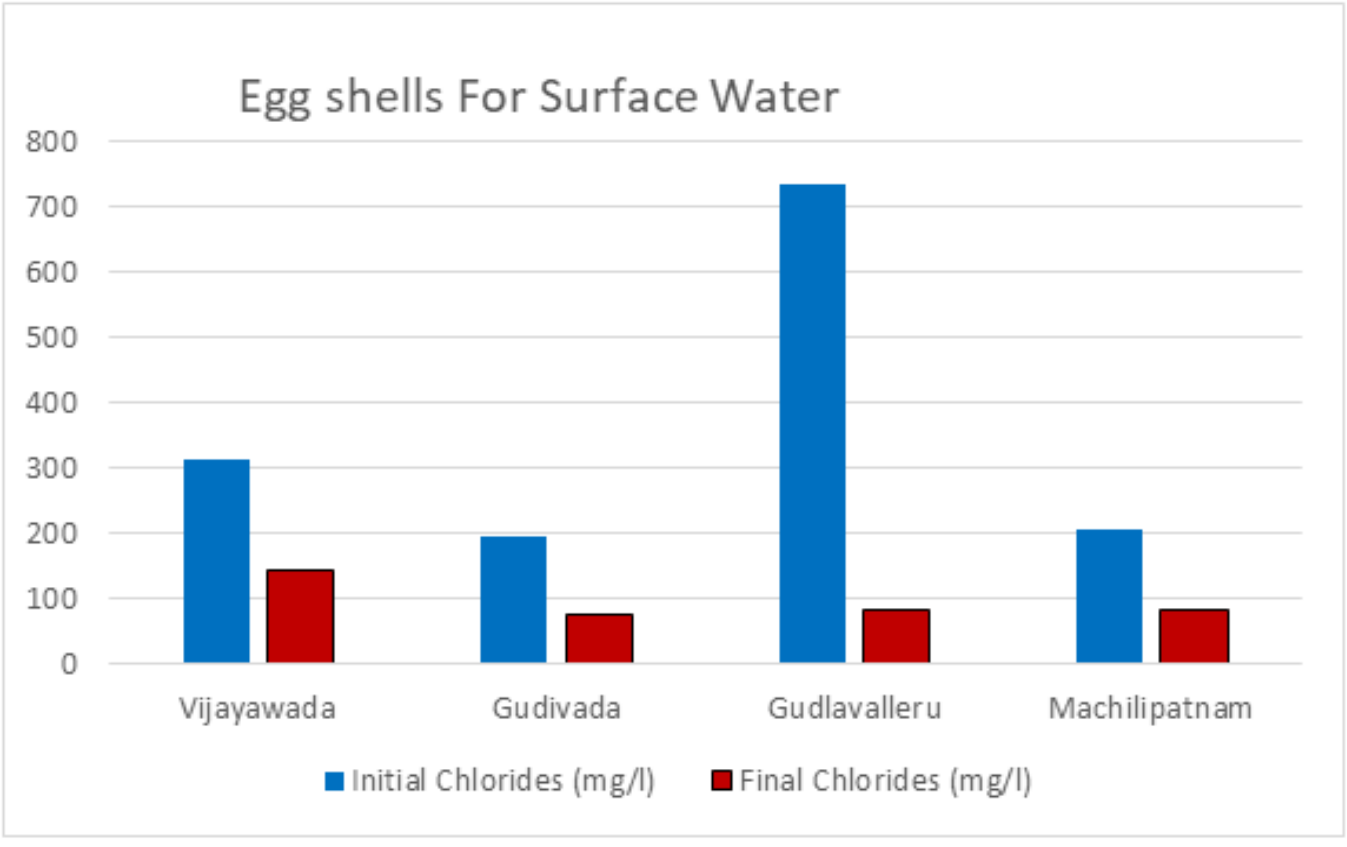


Fig 10 Initial and Final Chloride Content in Surface Water

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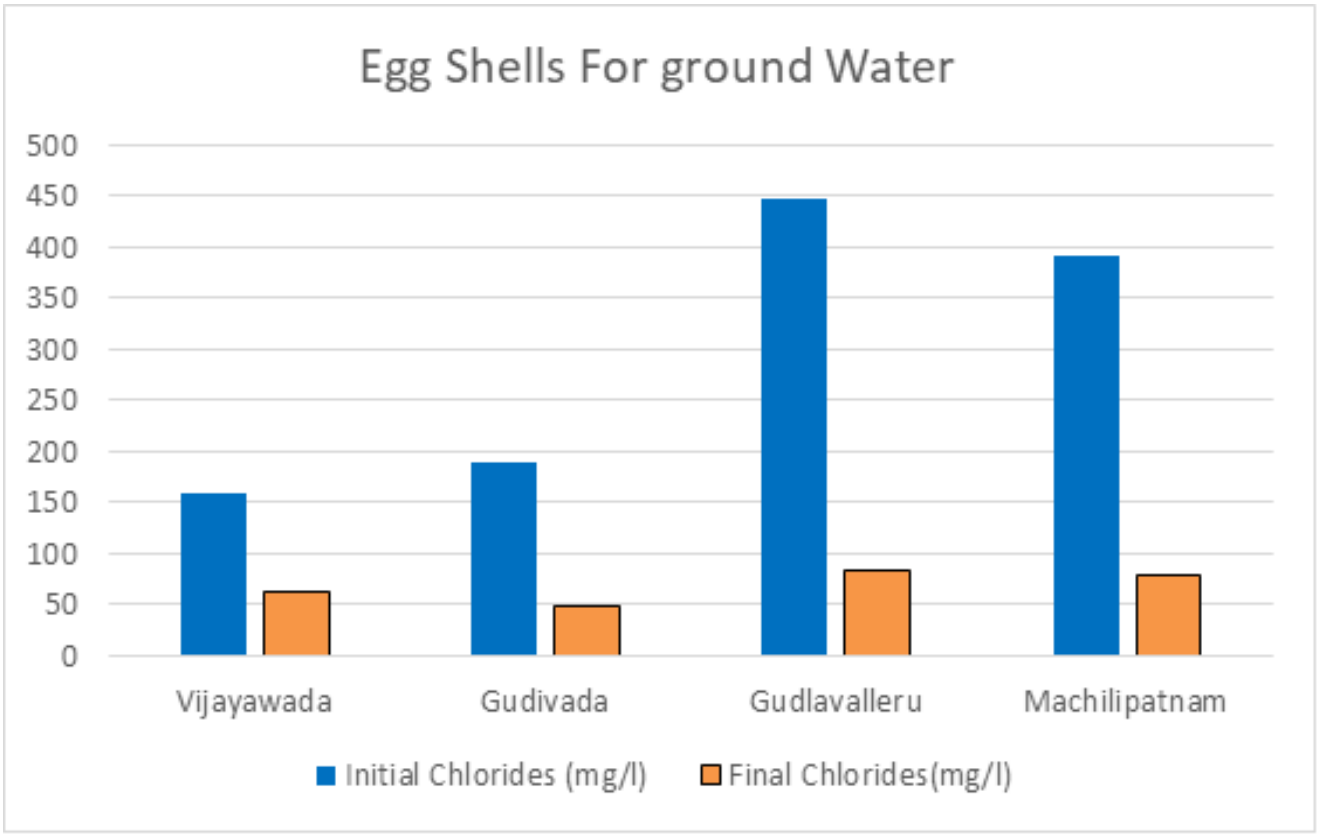


Fig 11 Initial and Final Chloride Content in Ground Water

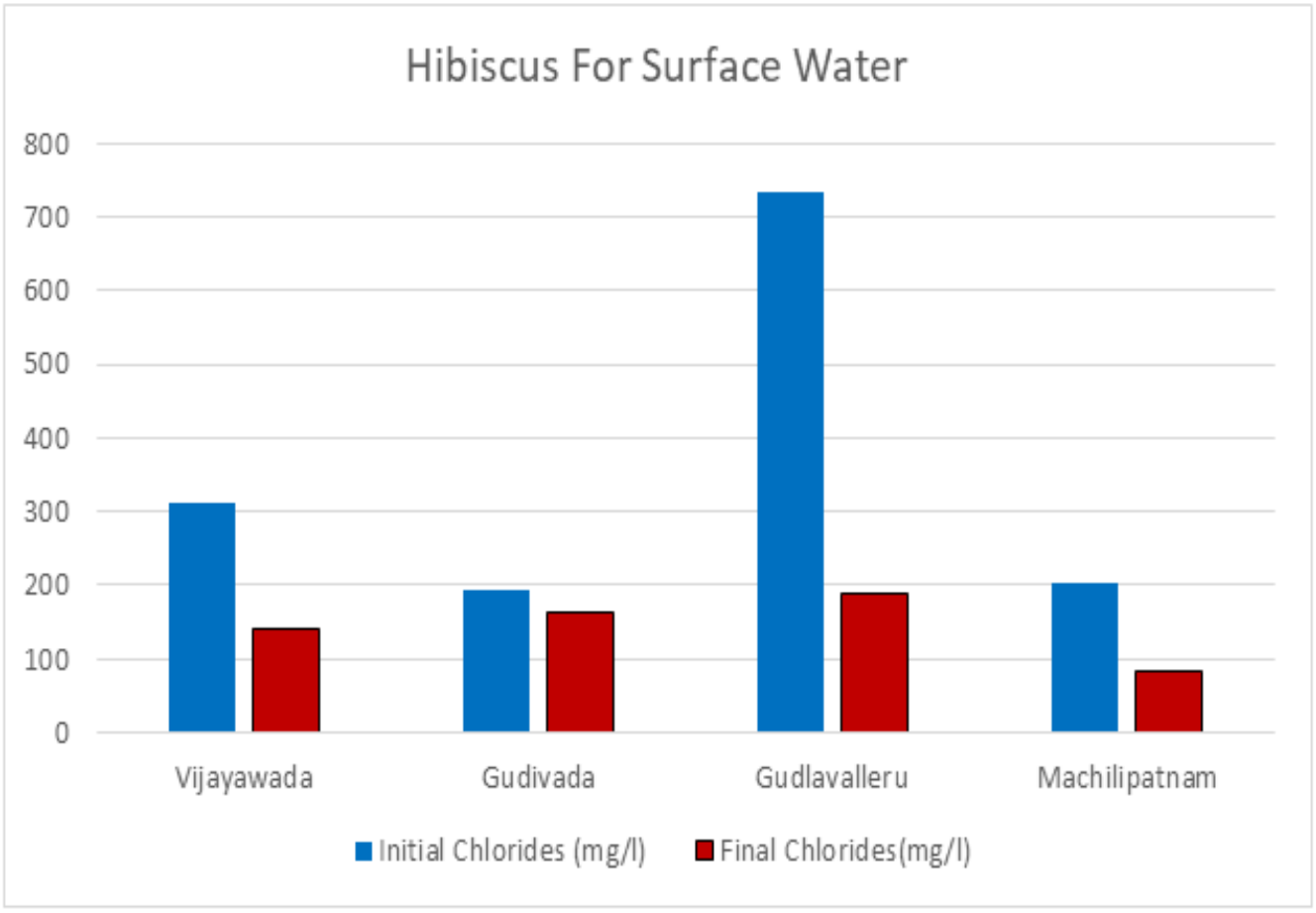


Fig 12 Initial and Final Chloride Content in Surface Water

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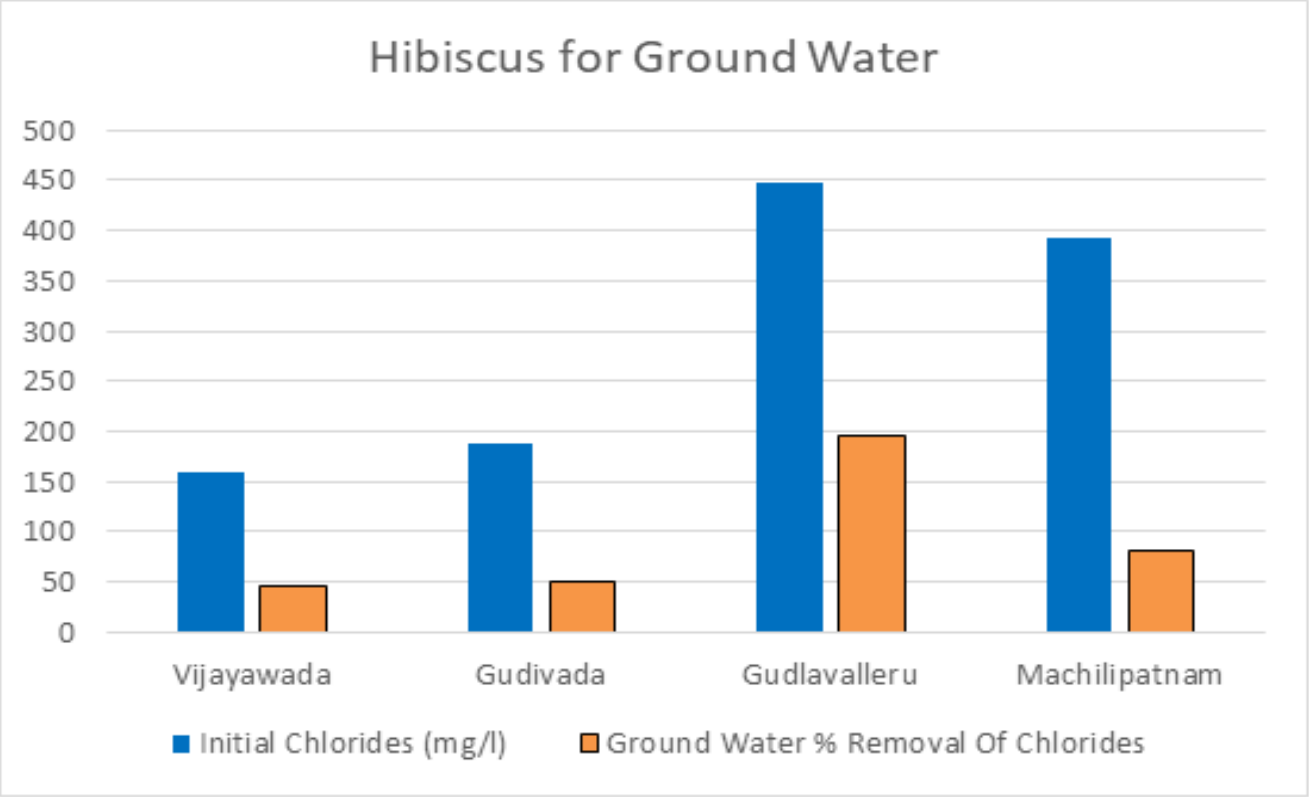


Fig 13 Initial and Final Chloride Content in Ground Water

## III. CONCLUSION

The Eight biosorbent materials are tested for chloride removal by adding them to chloride contaminated water. Egg shells and Hibiscus bio-adsorbent shows the best result When comparing to Rice Husk, Saw Dust, Parthenium, Mari Light, Chrysanthemum for removal of chlorides and further it is tested in various optimum parameters.

➢ *Parameters of Eggshells:*

- By using Egg shells, chloride removal of 65-82% can be achieved.
- The required temperature for this process is 25-35$^0$C.
- pH for this process is 6.5-7.
- Contact time for this process is 60 minutes.
- Agitation speed for this process is 90 rpm.

➢ *Parameters of Hibiscus*

- By using Hibiscus, chloride removal of 80% can be achieved.
- Temperature for this process is 30-35$^0$C.
- Ph for this process is 5.5-6.
- Contact time for this process is 60 minutes.
- Agitation speed for this process is 120rpm.

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