Treatment of Contaminated Water Using Eco-Friendly Material

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Abstract. In the existing situation, wastewater treatment is a challenging issue for living organism and biophysical environment. The polluted water sources posture a serious issue concerning the various health hazards they bring along. Renewable methods involving the use of ecofriendly and natural materials for pollutant removal from wastewaters can offer a satisfactory solution suitable well with the characterization of sustainability. A water purification process is designed to remove or reduce existing water contaminants to the point where the water is fit for use. The purification technologies used in this experiment will help to remove the contaminants and give clear appearance to water in addition to the improvement in its smell and taste. Due to low cost and local availability of the materials used, this method is easy and can be preferred by everyone. By using natural materials, it not only removes the contaminants it adds nutrients to the water also which is good for health. The material Strychnos potatorum, Zea mays, Chrysopogon zizanioides, Cuminum cyminum, activated charcoal, sand gravel helps to remove all the physical and chemical parameters from water and make the water drinkable.

Keywords: water purification, Strychnos potatorum, Chrysopogon zizanioides, Cuminum cyminum, activated charcoal.

1. Introduction

Energy efficient, small cost and chemical free method of water purification has become a humanity need due to the increase in demand of pure water day by day [1]. Renewable approaches involving the use of natural materials for pollutant removal from wastewaters can offer a favorable solution fitting well with the definition of sustainability [2]. For setting or buying water purifier may cost high and which can only be used properly for a year. As much the world is been developing that much the availability of water is been contaminated in different ways. There are three sources in which the waste water is been collected, they are from home, agriculture and industries. In this the industrial waste water is more harmful which was discharged with heavy pollutants by affecting the surrounding environment. The type of water present is detergent, oil, salts, color and dyes, pesticides, toxic chemicals and heavy metals [3]. A solution had to be derived to purify these industrial waste water and removing or reducing the toxic parameters.

The water was not only having contaminants, it has also the bacteria which will cause many diseases to the living organisms and which will make the organisms present in water to die. Not only bacteria’s, the hazards which is released from chemical industries will also cause high
thread to organisms. For centuries, surface water has been treated traditionally using herbs as natural coagulants in India. Ripe seeds of Strychnos popatorum, wiry roots of the rhizome of Vetiveria zizanioides, seed coat of lettaria cardamomum and leaves from Phyllanthus emblica were popular for their use in water treatment. Moring seeds can also be used for water purification to remove the turbidity, alkalinity and total dissolved solids.

The quality of water was decreasing and the demand for pure water is increasing day by day. To buy a water purifier is bit costly. To get a pure drinkable water without contaminants which will be good for health. Water purification is the process of removing undesired chemical biological, contaminants, suspended solids and gases from contaminated water. It is very important to purify the water before it is used for domestic purposes. To find the best quality water purifier, to improve the water quality of wastewater, to remove all the contaminants from water and to make the water usable for other purpose and to prevent from harmful disease, to attain or to improve the quality of water was done by using only natural material without using any of the chemical material.

Microbiological contaminants is generally the most important to human health as this leads to infectious diseases which affect all populations groups, Many of which may cause epidemics and can be fatal. Chemical contamination which has the exception of a few substances such as cyanide and nitrate tends to represent a more long-term health risk. The charcoal is used as an good adsorbent for removing the heavy metal pollutants in water [11-14]. Substances in water which affect the clarity, color or taste of water may make water objectionable to consumers and hence ability to recover costs [3-10]. The objective of the study was to determine the low cost and eco-friendly water purifier by using non-biodegradable material for treatment. This water is preferred for domestic purpose as drinking water by removing undesired chemicals, materials and biological contaminants.

2. Materials and Methods

To carry out the study, selection of purification material was very important. By using these ecofriendly materials, a low-cost purifier had to be prepared. The materials such as Strychnos potatorum (nirmali seeds), Zea mays (corn cobs), Chrysopogon zizanioides (Khus grass roots), Cuminum cyminum, activated charcoal, sand gravel were collected initially.

Strychnos potatorum (Nirmali seeds) commonly known as the clearing nut tree. In Ayurveda, Susruta mentions the use of its seeds for clearing muddy water. Nirmali, botanically known as Strychnos potatorum (Linn), belongs to the family Loganiaceae, known as Nirmali in hindi and Bengali and Tettrankottata in Tamil, it is a tall deciduous tree growing up to a height of over 12 meters. Ripe seeds are used for clearing muddy water. It settles the colloidal Matters suspended in muddy water. The water-clearing quality of the seed is due to the presence of alkaloids. Analysis of the family powdered seeds gave following details – Moisture 8.2 per cent, nitrogen .33 per cent, alkaloids 0.17, bromine, ash 1.34, sucrose 1-2 and loganin.

In developing countries, ground water, which is contaminated with domestic and industrial waste, is commonly content affect quality of potable water. The seed of Nirmali tree Strychnos potatorum Linn. Shows coagulation properties in clearing turbid water. This property was attributed to the presence of anionic polyelectrolytes having-COOH and free -OH surface groups that are present in the seed protein. Nirmali seed is good for health in many ways. It is used for the treatment of many diseases. It serves as important therapeutic agents as well as important raw material for the manufacture of traditional and modern medicines.

Corn cobs

The Corn cob is thee leas utilized part of the maize plant. Having high mechanical strength, rigidity and porosity, corn cob is a suitable absorbent. This enables contaminants
like oxides of salts, detergent, suspended particles, colored dyes, oil, grease and some heavy metals to be absorbed on the surface of the corn cobs. If the drain pipe of the household is connected to a chamber having different layers of corn cobs in partition layers, it will separate contaminants including suspended particles from the waste water. Corn cobs has both absorbent and abrasive properties. The chaff and plinth provide absorbency while the woody ring has major abrasive properties. It is 100% environmentally friendly and silica free product. It controls the water evaporation rate. The pH value is 5.42 and electrical conductivity is 382μS-cm -1, which shows that it has high water absorption capacity. For this experiment I have collected the corn cobs, washed it and dried it for almost one month. After purifying the water, I have kept the corn cob pieces to know how long it can be used. After each experiment it should be kept under the sun and it can be used again many times.

**Khus grass root**

Vetiver grass (Vetiveria zizanioides (L.) Nash), a perennial grass, is fast growing grass with a deep root system and high biomass production. Due to its unique morphological production. Due to its unique morphological characteristics and its tolerance of adverse environmental conditions, it has been used effectively for wastewater treatment. Vetiver grass is been used in ancient times for the purification of water. It is rich in vitamin C. It has the property to remove nitrogen and phosphate from water.

### 2.1 Model Set up

The experiment study was carried as a small batch study which was shown in figure 1. The model set up carried out in three layers. In the first layer was filled with gravel of size 20mm, 65mm and sand of size 0.6mm. The large particles dust which was carried with water for purification will be removed first and then the small particles will be removed by the sand layer. The second layer itself divided in to five filter parts which contains the corn cobs as natural filter material. The first part of second layer was placed with 4cm length corn cob placed vertically first and then the corn cobs was placed horizontally as second part, then the corn cob powder alone as third part, then corn cob powder mixed with charcoal and finally below the second layer was filled with charcoal. The last layer of the column was filled with khus grass root. Then the water for treatment would pass through the first layer, where the larger and smaller dust particles will be removed, then allowed to pass through second layer, where the actual treatment process will start by means of the filter material.

![Figure 1](image)

**Figure.1. Experimental Model Layout**

### 2.2 Sample collection and purification

The water sample has been collected from two places where the water gets polluted. The sample was collected from well which is been not used for a period of time due to the salty taste and turbidity. In this batch study the collected material for purification was used. After the purification process the water quality parameter was analyzed. The
vetiver was treated by washing and drying it several times and used for the batch experiment. This experiment was carried over under room temperature, which was shown in the figure.2.

![Figure.2. Batch study Setup](image)

### 3 Results and Discussion

The water sample has been collected from two different places in Chennai. The sample was been collected from well which is been not used for a period of time due to the salty taste and turbidity. The collected water initially observed with some odour, change in colour and change in taste was the first evidence of a problem. Colour in water may be caused by a number of contaminants such as iron which changes in the presence of oxygen to yellow or red sediment. Colour from iron is referred to as "apparent colour" rather than "true colour". True colour is distinguished from apparent colour by filtering the sample.

pH is a measure of how acidic or basic water is. The range goes from 0 - 14, with 7 being neutral. pH of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base. The the EC or Electrical Conductivity of water is its ability to conduct an electric current. Salts or other chemicals that dissolve in water can break down into positively and negatively charged ions. These free ions in the water conduct electricity, so the water electrical conductivity depends on the concentration of ions. Salinity and total dissolved solids (TDS) are used to calculate the EC of water, which helps to indicate the water’s purity.

Dissolved solids refer to any minerals, salts, metals, cations or anions dissolved in water. Total dissolved solids (TDS) comprise inorganic salts (principally calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulphates) and some small amounts of organic matter that are dissolved in water.

The presence of TDS was mainly due to the presence of calcium and magnesium ions in the water. Calcium is a determinant of water hardness, because it can be found in water as Ca\(^{2+}\) ions. Magnesium is the other hardness determinant. Calcium is present in various construction materials, such as cement, brick lime and concrete. The next one was magnesium which was washed from rocks and subsequently ends up in water.

Chlorides are salts resulting from the combination of the gas chlorine with a metal. In combination with a metal such as sodium it becomes essential for life. Small amounts of chlorides are required for normal cell functions in plant and animal life. Alkaline compounds in the water such as bicarbonates (baking soda is one type), carbonates, and hydroxides remove H\(^+\) ions and lower the acidity of the water (which means increased pH). They do this usually by combining with the H\(^+\) ions to make new compounds. Without this...
acid neutralizing capacity, any acid added to a river would cause an immediate change in the pH. Measuring alkalinity is important to determining a river's ability to neutralize acidic pollution (as measured by pH) from rainfall or snowmelt. It’s one of the best measures of the sensitivity of the river to acid inputs.

The contaminated water was treated through these layers which was shown in figure 2 and the water sample was analyzed before and after treatment and shown in table 1 and table 2. From the analysis it was observed that these natural materials were acting as a good adsorbent and removing the contaminants to the desirable level. All the water quality parameters were reduced to acceptable level. The odour of the water also reduced to desirable limit. The suspended solids and turbidity of water reduced in the first layer itself. The result was shown in figure 3 and figure 4. There are also some challenges occurred during this study was colour of the water. As the main naturally treated material used was khus grass root normally called as vetiver. The final treated water colour was pale yellow, as the water was travelling with these roots.

| Sl no | Physical examination | Initial result | Final result |
|-------|----------------------|----------------|--------------|
| 1     | Appearance           | Turbid         | Non-turbid   |
| 2     | Odour                | Smelly         | Agreeable    |
| 3     | pH @ 25 ºC           | 7.31           | 6.98         |
| 4     | Electrical conductivity@ 25ºC | 2460 | 2145 |
| 5     | Total dissolved solids | 1722 | 1290 |
| 6     | Total hardness as CaCO3 | 580 | 496 |
| 7     | Calcium as Ca        | 160            | 149          |
| 8     | Magnesium as Mg      | 43             | 30           |
| 9     | Chloride as cl-      | 475            | 462          |
| 10    | Sulphate as SO4      | 92             | 116          |
| 11    | Total alkalinity as CaCO3 mg/L | 312 | 242 |

The main advantage of this natural purifier was the bacteria present in the water will be removed naturally. Another main important advantage was the cost of the set up was very economical as the materials were naturally easily available and eco-friendly material. The set up of this purifier was easy so that anyone can handle with this set up. And most important part of this study is nutrients, which will be added naturally to the water while treating. The main disadvantage was, the natural material used for treatment has to be changed periodically and the effectiveness will be reduced if the replacement of material was not carried over by a
periodical time. This set up should be carried out in a closed room and compared to other
purifier the materials added and process of purification was less, which can improve by further
study.

Table 2 : Water Sample Analysis of Sample 2

| Sl no | Physical examination | Initial result | Final result |
|-------|----------------------|----------------|--------------|
| 1     | Appearance           | Turbid         | Non-turbid   |
| 2     | Odour                | Smelly         | Agreeable    |
| 3     | pH @ 25 °C           | 7.77           | 7.58         |
| 4     | Electrical conductivity@ 25°C | 4978     | 3956         |
| 5     | Total dissolved solids | 2396       | 2163         |
| 6     | Total hardness as CaCO₃ | 1002       | 510          |
| 7     | Calcium as Ca        | 177            | 97           |
| 8     | Magnesium as Mg      | 136            | 138          |
| 9     | Chloride as cl⁻      | 1277           | 1108         |
| 10    | Sulphate as SO₄      | 79             | 113          |
| 11    | Total alkalinity as CaCO₃ mg/L | 668       | 568          |

Figure 4: Water sample Analysis of Sample 2

4 Conclusion

The aim of the investigation was to use of natural material to remove the contaminants
of polluted water using ecofriendly material. These materials are renewable, rich,
environmentally friendly, adaptable and biodegradable. Thus, we can use these products as
filter material for water purification which will also add nutrients to the treated water by
the presence of khus grass root (vetiver). The material corn cob, khus grass root (vetiver),
cumin seed activated charcoal, sand gravel adsorb the contaminants and reduced the
physical and chemical parameter of water. The water quality parameter after observed was
acceptable with desirable limit. The further study can be carried over by using these
ecofriendly material as an adsorbents or removing heavy metal present in water.

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