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# GREY WATER TREATMENT SYSTEMS AND REUSE STRATEGIES

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**ABSTRACT**

This study presents a literature review of the quality of Grey water generated in different, especially developing, countries, constituents found in Greywater, some treatment systems, and natural materials for treatment, some reuse strategies and public perception regarding grey water reuse. The review shows that generation rates are mostly influenced by lifestyle, types of fixtures used and climatic conditions. Contaminants found in grey water are largely associated with the type of detergent used and influenced by other household practices. Many of the treatment systems reviewed were unable to provide total treatment as each system has its unique strength in removing a group of targeted pollutants. The review revealed that some naturally occurring materials such as Moringa oleifera and sawdust can be used to remove targeted pollutants in grey water. The study further showed that user perceptions towards grey water treatment and reuse were only favourable towards non-potable purposes, mostly due to perceived contamination or lack of trust in the level of treatment offered by the treatment system. It was then allowed to downflow through the vertical column from the top at the flow rate of 0.5 ml/min. The treated outlet was collected at the interval of 7 days from the outlet Nozzle provided at the bottom of the column and their characteristics were analysed and compared with the initial.

**Keywords: Grey water, contaminant, Reuse.**

## INTRODUCTION

The total volume of fresh water on Earth far outweighs human demands. Out of the overall water resources on Earth, about 97% can be found in the oceans while the remaining 3% remains available for direct exploitation; however, out of this 3%, the quantity of water that is available for use by humans is estimated at one-hundredth. Uneven distribution of water in both time and space sways the use of water to other geographical areas depriving others of this resource. Biological survival remains one of the key factors of water use with its associated use also for household needs and food production and other developmental needs. Many parts of the world are hit by acute water shortage, over-exploitation of water resources leading to the gradual destruction of these water resources and high levels of freshwater pollution resulting from anthropogenic factors. Currently, it has been estimated that about 800 million people live under a threshold of water stress and this number is expected to reach 3 billion. Grey water is defined as wastewater without any contributions from toilet water It is considered high volume, low strength wastewater with high potential for reuse and application. The composition of grey water is varied and depends on the lifestyle, fixtures and climatic conditions. Reuse of grey water has been an old practice, and it is still being done in water-stressed areas.

Grey water reuse has been considered a reliable method of ensuring water security as compared to other methods of water capture such as rainwater harvesting which is dependent on hydrological conditions. The amount of grey water produced in a household can vary greatly ranging from as low as 15 L per person per day for poor areas to several hundred per person per day. Factors that account for such huge disparities are mostly attributed to geographical location, lifestyle, climatic conditions, type of infrastructure, culture and habits, among others. Grey water accounts for up to 75% of the wastewater volume produced by households, and this can increase to about 90% if dry toilets are used. It has also been estimated that grey water produced accounts for about 69% of domestic water consumption. When grey water is mixed with toilet wastewater, it is called sewage or black water and should be treated in sewage treatment plants or an onsite sewage facility, which is often a septic system If stored, it must be used within a very short time or it will begin to putrefy due to the organic solids in the water.

Most grey water is easier to treat and recycle than sewage because of lower levels of contaminants. If collected using a separate plumbing system from black water, domestic grey water can be recycled directly within the home, garden or company and used either immediately or processed and stored. If stored, it must be used within a very short time or it will begin to be putrefy due to the organic solids in the water. Recycled grey water of this kind is never safe to drink, but some treatment steps can be used to provide water for washing or flushing toilets. The treatment processes that can be used are in principle the same as those used for sewage treatment, except that they are usually installed on a smaller scale (decentralized level), often at the household or building level:

- Biological systems such as constructed wetlands or living walls and more natural 'backyard' small-scale systems, such as small ponds or bio-diverse landscapes that naturally purify grey water.
- Bioreactors or more compact systems such as membrane bioreactors are a variation of the activated sludge process and are also used to treat sewage.
- Mechanical systems (sand filtration, lava filter systems and systems based on UV radiation)

A basic grey water filtration system can be made at home by anyone. Greywater is first passed through a coarse mesh filter bag. This removes any large particles such as lint and hair immediately. The grey water is then passed through a much finer filter to remove the small particles. The untreated Grey water characteristics from each source House holdings are represented in Table 1

**Table 1: Characteristics of Greywater characteristics**

| Water source | Characteristics |
|---|---|
| Bathroom | Microbiological: lower levels of thermo tolerant coliforms<br>Chemical: soap, shampoo, hair dyes, toothpaste and cleaning chemicals<br>Physical: high in suspended solids, hair, and turbidity<br>Biological: lower levels of concentrations of biochemical oxygen demand |
| Kitchen | Microbiological: variable thermo tolerant coliform loads<br>Chemical: detergents, cleaning agents<br>Physical: food particles, oils, fats, grease, turbidity<br>Biological: high in biochemical oxygen demand |

Grey water can be used untreated, or it can be treated to varying degrees to reduce nutrients and disease-causing microorganisms. The appropriate uses of grey water depend on both the source of grey water and the level of treatment.6 Recycled water is most commonly used for non-potable (not for drinking) purposes, such as agriculture.

## MATERIALS AND METHODS

The composition of grey water varies, and it is largely a reflection of the lifestyle and the type and choice of chemicals used for laundry, cleaning and bathing. The quality of the water supply and the type of distribution network also affect the characteristics of grey water. There will be significant variations in the composition of greywater in both place and time which may be due to variations in water usage to the discharged quantity. The composition may also be affected by chemical and biological degradations of some compounds within the transportation and storage network. Generally, greywater contains high concentrations of easily biodegradable organic materials and some basic constituents which are largely generated from households.

To identify the different chemical constituents in grey water, it is important to understand the sources of contaminants. Significant chemical constituents in grey water are chemicals used for cleaning, cooking and bathing purposes. The pH in grey water to a large extent depends on the pH and alkalinity in the water supply and normally is within the range of 5–9. Grey water with most of its sources originating from the laundry will generally exhibit high pH due to the presence of alkaline materials used in detergents. The major chemical constituents found in grey water which is generated as a result of cleaning or washing activities are surfactants. These surfactants serve as the main active agent in most cleaning products. Nutrients such as N and P are associated with kitchen and laundry activities. Grey water sources with high nutrient concentrations are mostly made up of a high fraction of kitchen and laundry sources. Kitchen waste is the primary source of nitrogen in grey water and ranges between 4 and 74 mg/L while washing detergents are the primary source of phosphates found in grey water which also ranges between 4 and 14 mg/L. Seeds from the Moringa tree have unique water purification properties. The seed extract can separate unwanted particulates from water sedimenting impurities. They also have potential as an anti-microbial treatment – the unprocessed seed powder may sediment over 90% of the bacteria from raw water.

**Figure:1 Seeds from the Moringa tree**

Sawdust is another inexpensive and useful bio absorbent for treating inorganic metal impurities from wastewater. It is available in large amounts at all places, is environment friendly, and is a very efficient adsorbent for treating the dyes and inorganic contaminants from water. It can be modified by different chemical treatments to increase its adsorption characteristics. Saw dust modified using acid hydrolysis can be utilized to treat pollutants, for example, dyes, heavy metal ions, and inorganic impurities from wastewater. Carbon /Nitrogen ratio (C/N), inoculation, particle size, and total solids (TS) content. The batch results indicated that the optimum parameters were: 20%, 30%, 2 mm, and 15%, respectively.


**Figure:2 Saw Dust**

## RESULT AND DISCUSSIONS

In general, the Tamil Nadu state has a rapid increase in urban population i.e., the proportion of the urban population increased from 24.4 per cent in 1951 to 48.5 per cent in 2011. The lack of adequate wastewater treatment facilities has resulting untreated sewage disposal into lakes, rivers and other water bodies. The cumulative result of unmanaged wastewater that the system cannot cope with hurts the health of people and ecosystems and is a challenge for ULBs. Conventional wastewater treatment as compared to decentralized treatment requires huge running costs for operation and maintenance over and above capital assets, energy cost and land availability.

In this, the recycling and reuse of grey water are taken up as an initial target. Grey water can be defined as any domestic wastewater produced, excluding sewage. People need to be made known the benefits of grey water recycling and re-use. The recycled grey water can be used for domestic, green belt development and other needs except drinking. A load of grey water is high in multi-story buildings, commercial complexes etc. Cost-effective methodologies will be evolved if necessary with prototype plants to use the treated wastewater.

At the individual or household level, the most water is utilized in flushing, followed by gardening, bathing and washing. Water consumption can be reduced by using water-efficient fixtures that take care of the excessive flow of water. Also, water used in low-end activities, such as flushing, can be replaced by treated wastewater. The local reuse of treated wastewater can help replace water for bulk urban requirements. Water for public utilities need not always be in large amounts. The quality of water required for what comes under public demand, such as for maintaining public parks, gardens and public fountains, and cleaning public toilets, will be different from the quality of potable water. Ground elements in greywater.

Laundry wastewater was found to contain elevated sodium levels compared to other types of greywater. The sodium in the laundry wastewater may be caused by the use of sodium as a counter ion to several anionic surfactants used in powder laundry detergent and the use of sodium chloride in ion-exchangers.

**Case: 1 Filtration of 15 cm Moringa oleifera and 20cm of sawdust-packed bed**

Table 2 shows that the initial and final results of grey water treatment can be carried out weekly for up to 4 weeks the values are taken and tested. It shows that the characteristics of sullage from 15 cm Moringa oleifera, and 20cm of sawdust packed bed

**Table:2 Characteristics of Sample after passing the filter Bed**

| SI. No | Weeks | pH | Total Solids (mg/L) | DO (mg/L) | Total Dissolved Solids (mg/L) | BOD (mg/l) | COD (mg/l) |
|---|---|---|---|---|---|---|---|
| | **Initial** | 8.2 | 58 | 42 | 510 | 604 | 1572 |
| 1 | 1st | 7.87 | 42 | 32 | 489 | 554 | 802 |
| 2 | 2nd | 7.48 | 40 | 30 | 468 | 523 | 674 |
| 3 | 3rd | 7.13 | 39 | 28 | 445 | 496 | 512 |
| 4 | 4th | 7.1 | 40 | 31 | 450 | 341 | 456 |

Figure 3 shows that the pH value has been tested and it can be shown in the graph by weekly report in that first week to the fourth week comparatively decreases and it works in the final result. The pH value ranges from 7.1 to 8.2 and it indicates that the sample is an alkaline nature

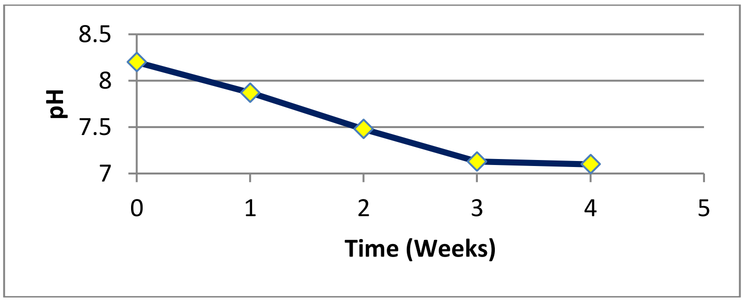


**Figure :3 Variations of pH**

Figure 4 indicates that the Total Solids value has been tested and it can be shown in the graph by the weekly report that the first week to the fourth week comparatively decreases and it works in the final result. Total solids values varied from 58 to 40mg/lit and dissolved oxygen values decreased from 42 mg /l to 21 mg/l.

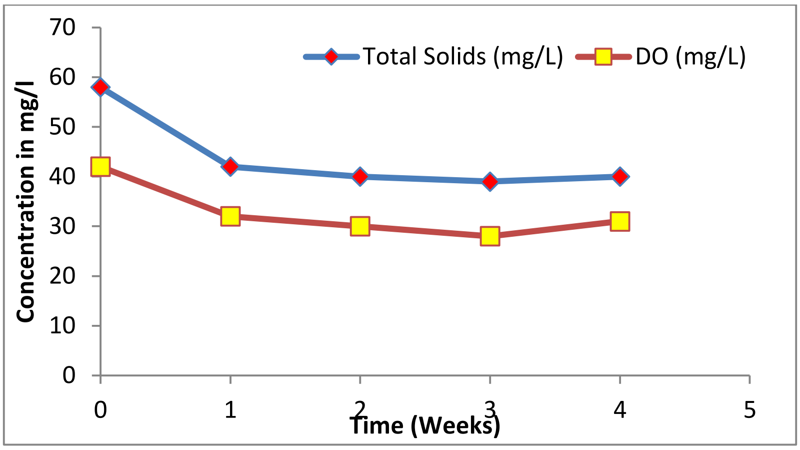


**Figure:4 Variations of Total solids and DO**

Figure 5 shows the Total Dissolved Solids, BOD and COD variation before and after treatment. The TDS value decreased from 510 mg/l to 445mg/l in the third week. Similarly, the BOD values were reduced from 604 mg/l to 341 mg/l. The COD value was also reduced from 1572 mg/l to 456 mg/l.

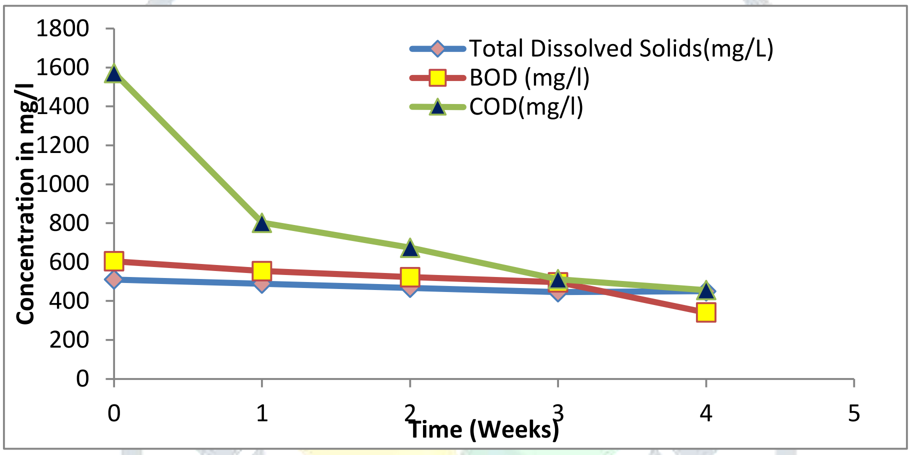


**Figure: 5 Variations of TDS, BOD and COD**

**Case: 2 Filtration of 20 cm Moringa oleifera and 20cm of saw dust-packed bed**

**Table :3 Characteristics of Sample after passing the Filter Bed**

| SI.NO | Weeks | pH | Total Solids (mg/L) | DO (mg/L) | Total Dissolved Solids (mg/L) | BOD (mg/l) | COD (mg/l) |
|---|---|---|---|---|---|---|---|
| | **Initial** | 8.2 | 58 | 42 | 510 | 604 | 1572 |
| 1 | 1st | 7.67 | 45 | 34 | 478 | 545 | 812 |
| 2 | 2nd | 7.33 | 40 | 29 | 458 | 524 | 674 |
| 3 | 3rd | 7.9 | 36 | 24 | 435 | 492 | 536 |
| 4 | 4th | 7.2 | 34 | 24 | 420 | 378 | 476 |

Table 3 shows that the characteristics sample of sullage from 20 cm Moringa oleifera and 20cm of saw dust packed bed

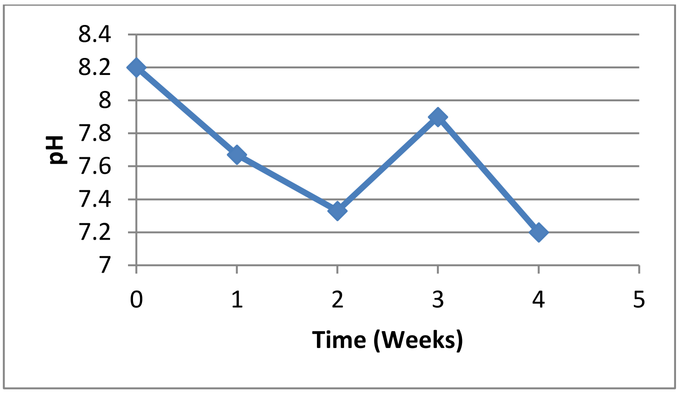


**Figure :6 Variations of pH**

Figure 6 shows that the pH value has been tested and it can be shown in the graph by weekly report in that first week to fourth week comparatively decreases and it works in the final result. The pH value ranges between 7.2 to 8.2 and it indicates that the sample is in alkaline nature

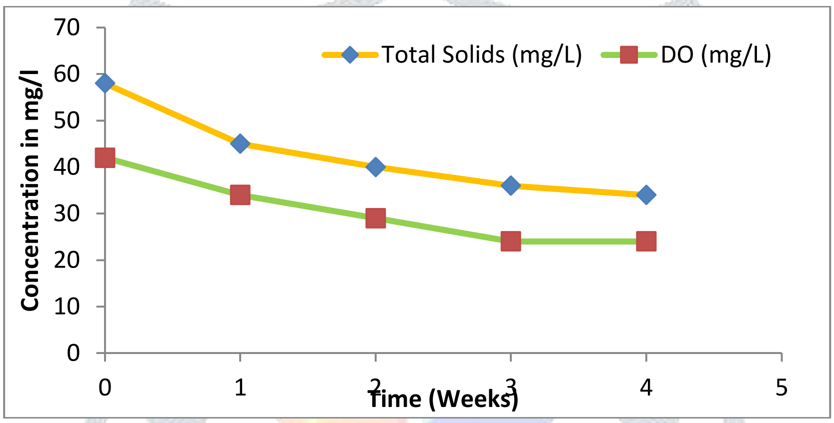


**Figure :7 Variations of TS and DO**

Figure 7 indicates that the variation of Total Solids and its value decreases. The values are varied from 58 to 34 mg/lit and dissolved oxygen values decreased from 42 mg /l to 24mg/l. Figure 8 shows that the Total Dissolved Solids, BOD and COD variation of before and after treatment. The TDS value has been decreased from 510 mg/l to 420mg/l in the fourth week. Similarly the BOD values were reduced from 604 mg/l to 378 mg/l. The COD value also reduced from 1572 mg/l to 476 mg/l.

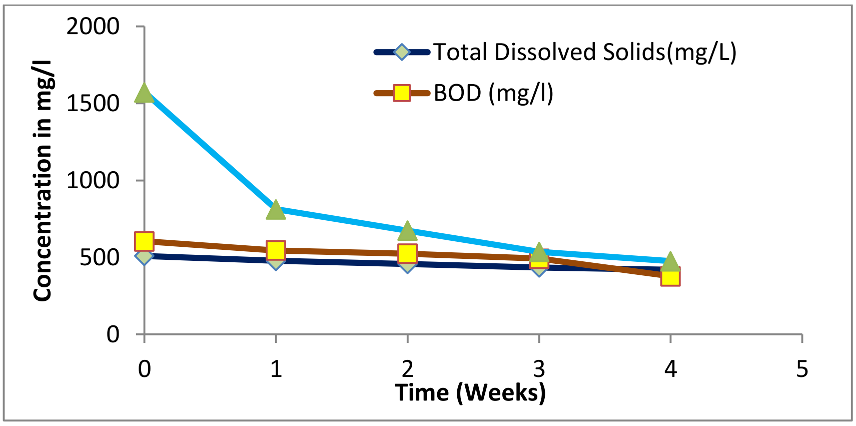


**Figure :8 Variations of TDS, BOD and COD**

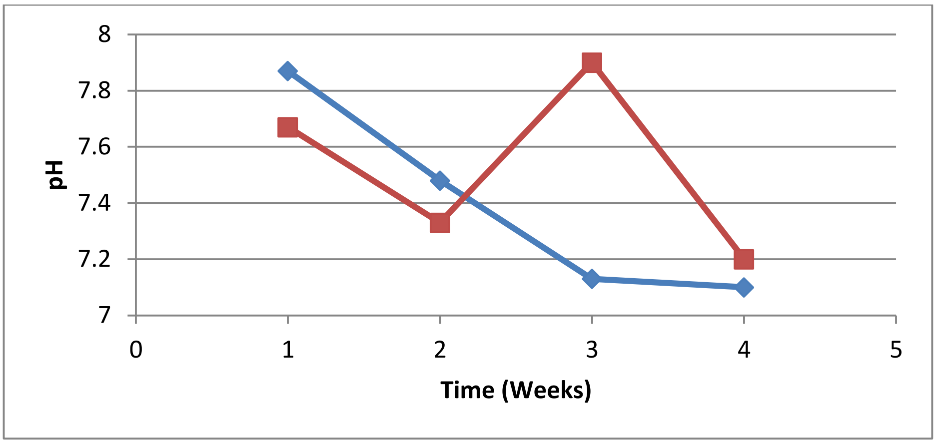


**Figure :9 Comparison of pH**

Figure 7 to 9 indicates that the comparison value of different characteristics for two different cases of filter bed.

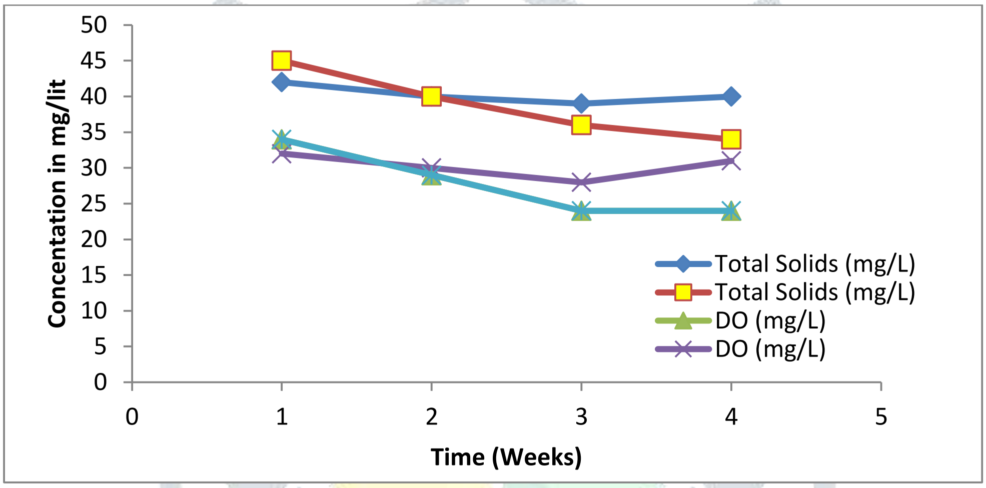


**Figure :10 Comparison of TDS, BOD and COD**

Figure 10 indicates that the comparison value of different Comparison of TDS, BOD and COD. Figure 11 indicates that the comparison value of different characteristics Comparison of TDS, BOD and COD.

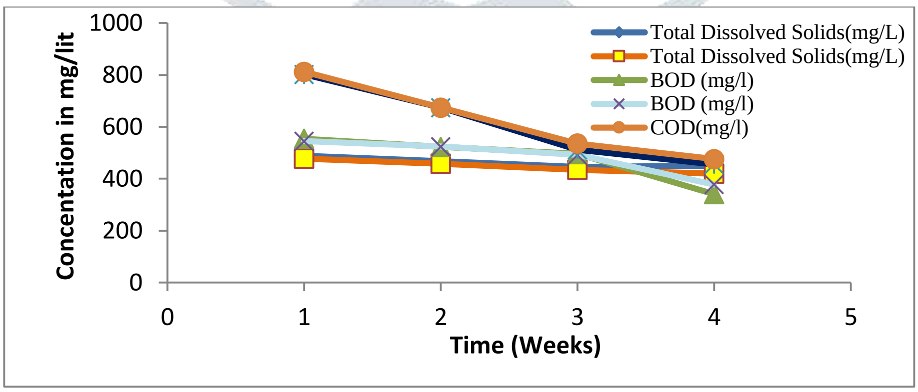


**Figure :11 Comparison of TDS, BOD and COD**

This study reviewed grey water characteristics, treatment systems, reuse strategies and perception of grey water reuse among users. It shows that there is a wide variation in grey water characteristics and volume generation rates which is largely dependent on the water use, lifestyle patterns and type of settlement. From the list of reviewed conventional treatment systems, filtration methods seem feasible and have the potential of integration with other systems to achieve target specific treatment. The study described different reuse strategies, most using discharged grey water for food production and landscaping while others have been used for poverty alleviation in irrigation farming.

## CONCLUSION

The samples were collected and its characteristics were analysed and observed such that pH as 8.2, Turbidity as 420 NTU, Chemical oxygen Demand as 1572 mg/l, Biological Oxygen Demand as 604 mg/l, Total Solids as 58 mg/l and TDS as 510mg/l. Thus the evaluation of the performance of treatment using two locally available low cost natural adsorbents such as moringa oleifera and saw dust were analysed by using fixed bed Vertical column adsorption Studies separately for each adsorbent. The treated outlet collected at the interval of 7 days from the outlet Nozzle provided at the bottom of the column and their characteristics were analysed regularly. There is some difference in P H variation between these two adsorbents and is reduced to the value around 7.2. There is a remarkable change in Chemical Oxygen Demand and Biological Oxygen Demand at 7 weeks of time as12 mg/l and 476mg/l for moringa oleifera while for saw dust, the same is observed after 5 weeks of time as 64 mg/l and 378 mg/l. From the results analysed, it is observed that moringa oleifera as an Adsorbent is more efficient in reducing the Biological Oxygen Demand and Chemical Oxygen Demand when compared with the Saw Dust and showing better results in lesser duration of treatment. Hence saw dust can be used more efficiently in grey water treatment which is cost effective, easy to handle and easily available.

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