Efficient Greywater Treatment Using Natural Coagulants and Filtration Systems for Domestic Applications

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Abstract

The Present study is to determine the viability of reusing grey-water from the Government College of Engineering Kalahandi (GCEK) campus, with a particular emphasis on treatment techniques to satisfy household uses except drinking. Factors such as pH, turbidity, Total dissolved solids [TDS], Total suspended solids [TSS] and chemical composition were examined. Findings indicate, substantial amounts of suspended particles in the grey-water, needing efficient treatment. Moringa oleifera seed powder as natural coagulant at a dose of 50 mg/L removes TSS and lowers turbidity Upon, usage of an activated carbon filter removed TSS further thus water quality has enhanced. The treatment resulted in reducing turbidity up to 2 NTU, Total Suspended solids (TSS) and TotalSuspended Solids (TDS) are reduced to 150(mg/L),50(mg/L) respectively. The Water Quality Index [WQI] of both hostels, raised from category E to A after treatment, confirming the proposed model is effective for treating Grey water. It indicates the reutilization of grey-water can be accomplished by an appropriate treatment, to serve for sustainable water management. The study emphasizes how crucial efficient treatment is, to encourage grey-water reuse, which in turn lowers water consumption and the negative environmental effects of wastewater disposal.

Keywords: Greywater reus, Moringa oleifera seed powder, -Coagulation, Filtration system, Water Quality Index.

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1 Introduction

Greywater, a valuable resource often overlooked in sustainable water management, encompasses household wastewater generated from sources excluding toilets [1]. Optimizing greywater reuse is crucial for achieving a sustainable water cycle.
Typically, greywater includes water from showers, sinks, and laundry, with its chemical composition influenced by household or hostel activities [2]. Careful consideration of parameters like pH values, solids, and nutrient content is essential to ensure the effectiveness of treatment processes .The Integration of greywater into sustainable practices can be made possible essentially by public awareness and education. Communities have to be aware of the significance of greywater reuse in minimizing the demand for freshwater and treatment costs of wastewater. Optimizing greywater parameters for sustainable reuse aligns with a broader commitment to responsible water management, fostering resilience in the face of escalating global water challenges. Wastewater treatment has utilized coagulation since ancient times, primarily to remove colloidal foreign substances and water turbidity. Enormous variables, such as type of coagulant, dosage, pH, and the amount and type of organic substance used in the water, contribute to the productivity of coagulation. Re- searchers have conducted numerous tests to determine the optimal dosage for effective treatment [3]. Soil filtration is a method used to remove contaminants from water by passing it through layers of soil. The soil acts as a natural filter, capturing pollutants and impurities, resulting in cleaner water. This method is eco-friendly and cost- effective, providing an efficient way to decontaminate water. By optimizing these processes and raising awareness, we can integrate grey- water reuse into sustainable water management practices, ensuring a more resilient and resource-efficient future [4].

Greywater, defined as wastewater from household or hostel activities excluding toilet waste, generally exhibits good biodegradability. Greywater from bathrooms and laundry is low in nitrogen and phosphorus, whereas kitchen greywater has a characteristic COD ratio. However, unit operations alone cannot remove biological impurities; unit processes are also required to treat greywater. Reliable and cost-effective greywater recycling can therefore be achieved by combining biological processes with unit operations [5].

Greywater contains biological impurities are unsuitable for direct non-potable reuse despite its nutrient content [6]. The greywater treated is utilized for the purposes of irrigation in home gardens. [7]. Greywater represents accounts for a sizeable amount of residential water use. When treated to comply with reuse regulations, greywater can be reused for agriculture, landscaping, and toilet flushing.
Experiments on designed filter media consists of naturally available materials and examined the efficiency of filters in removing excess quantities of water quality parameter such as pH and TDS [8] [9]. The Weighted arithmetic water quality index (WAWAQI) to assessed the water quality using experimental results [10].

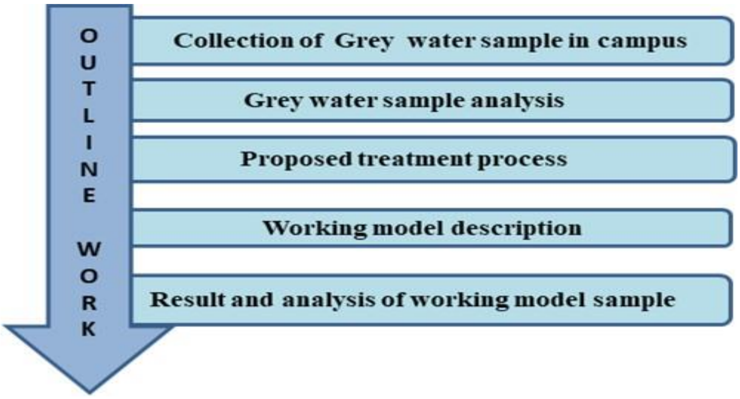

Fig. 1. Project outline

2 Methodology

The study area is Government College of Engineering, Kalahandi, Bhawanipatna, located at Western regional state of Odisha, India with 19.9144ºN latitude, 83.1063ºE longitude. Greywater samples were collected from two hostels named Abdul Pakir Jainul abdeen Hall of Residency (APJHR) & Visvesvaraya Hall of Residency (VHR) in Jan 2024 for a week on alternative days from various locations of hostels such as bathroom pipelines, and kitchen sinks. Figure 1 shows the outline of work.
The grey water samples were tested as per IS 3025 in the water and waste water engineering laboratory at the Government College of Engineering Kalahandi, Bhawanipatna, to determine the extent of physic chemical water quality parameters such as pH, Total Solids (Total SuspendedSolids & Total Dissolved Solids), Turbidity and Alkalinity. After obtaining the results, appropriate treatment methods were recommended to make the water viable for reuse. Then Water Quality Index (WQI) was calculated using the experimental results of the collected grey water samples at every stage of treatment process. Jar test is used to determine the optimum dose of coagulant need to remove suspended solids After including the appropriate weight of moringaoleiferaseed powder as coagulant ranged from 40mg/L to 90mg/L,the water was mixed at 100 rpm for 1min,the quick end reaction made a difference in scattering the coagulant throughout each holder. The blending speed was diminished to 20rpm and continued the blending for 20minutes. This slower mixing speed promoted floc formation by improving particle collisions, which led to the development of larger flocs. After deciding the coagulant dose using jar test the filtration system was installed using gravel activated carbon. A simple filtration model was designed to treat greywater. The parameters assessed were turbidity and pH, using activated carbon and silica sand as filtration media. Silica sand functions as filter by capturing large particles and debris, while activated carbon removes odours, tastes and certain substances from the water.

Activated Carbon with a sieve size of 2.25 mm referring to the average particle size of the carbon granules is utilized for adsorbing impurities and contaminants from grey water. Activated carbon is also known as activated charcoal is a type of charcoal with a surface structure characterized by very large pores. Due to its extensive surface area and numerous pores, activated carbon can be used to absorb enormous substances.
Silica sand with a sieve size of 425 microns is employed in filtration process due to its fine texture, which allows for efficient filtration. Silica sand refers to sand composed primarily

of silica dioxide (SiO2) in the form of microscopic crystals. Due to its beneficial properties, including heat resistance, corrosion resistance, and versatility, silica sand is use in various applications such as water treatment and industrial filtration systems, to get clean and purified water output. Gravel with a sieve size of 10 mm is utilized in filtration beds to support finer filtration media and ensure proper liquid flow. Gravel is commonly Consisting of small pieces of rock and pebbles larger than sand grains, its size allows for effective filtration while providing stability to the filtration system, making it ideal for water treatment and drainage systems, ensuring efficient and reliable filtration processes.

The water purification model is a user-friendly water filtration model designed for easy access to water suitable for domestic use. It is easy to install and does not require a large space. Design consisting of three containers, incorporates an alum treatment chamber in container 1, followed by sand (20 cm) and gravel (8 cm) in container 2. sand (10 cm), carbon charcoal (8 cm), and gravel (8 cm). in Container 3.

3 Result and Discussion

Table 1. Water quality parameters results of entire treatment process

Testing Parameter	VHR Hostel		APJHR Hostel	
	Pre-treatment	Post-treatment	Pre-treatment	Post-treatment
Total Suspended Solids(TSS),(mg/L)	810	150	987	120
Total Dissolved Solids(TDS),(mg/L)	700	67	490	50
Turbidity(NTU)	50.8	2	44.4	2.7
pH	7.55	6.7	7.73	6.7

This study evaluated grey water samples from hostels using the proposed filtration model, focusing on key water quality parameters like TSS, TDS, pH and Turbidity. The wastewater samples were analysed in laboratory results were compared withIS10500:2012. Drinking water standards. Grey water from hostels had total suspended solids, turbidity, and total dissolved solids are beyond the limits of standards. Initially to remove dissolved solids use moringa oleifera seed powder was used at rate of 50 mg/l with a contact time of 65 minutes in the container of proposed design. After that Filter bed is provided with activated carbon to remove the remaining particles present in grey water.
Table 1 presents the water quality parameters for the entire treatment process, showing that substantial removal of solids and turbidity was achieved using the proposed filtration system. DS levels decreased substantially, although they remain above drinking water standards, reaffirming the system’s suitability for non-potable applications. The use of activated carbon in the final filtration stage has effectively removed residual particles and organic compounds, enhanced water clarity and reducing odour. These outcomes underrate

how well the system treats greywater for applications, eg., irrigation, flushing of privy etc. The results confirms that filtration model is sustainable and cost effective by incorporating natural coagulant Moringa Olifer seed powder. These findings are particularly relevant for hostels and similar residential settings, where greywater can be safely reused for non-drinking purposes, reducing overall freshwater demand.

Water quality was tested for each parameter at every stage of the treatment process: pre-treatment, after coagulation, and post-treatment. Figure 2 shows the pH values at each stage; the observed pH ranged from 6.6 to 8.0, which falls within the limits specified in the drinking water guidelines (IS 10500:2012). Similarly, Figures 3 to 5 present the TSS, turbidity, and TDS results at each stage of treatment. The water quality at each stage of the proposed filtration model was assessed using the Weighted Arithmetic Water Quality Index (WAWQI) method, and the results are given in Table 2. The WQI of both hostels improved from Category E to Category A after treatment, indicating that the proposed filtration model effectively treated the greywater from the hostels.

Table 2. Water Quality Index at different stages of treatment

Water Quality Index(WQI)	VHR Hostel	APJHR Hostel	Water Quality status
Pre-Treatment	123.8	108.3	Requires treatment
After Coagulation	21.8	16.32	Use for Domestic applications
Post -Treatment	13.95	10.47	Use for Domestic applications

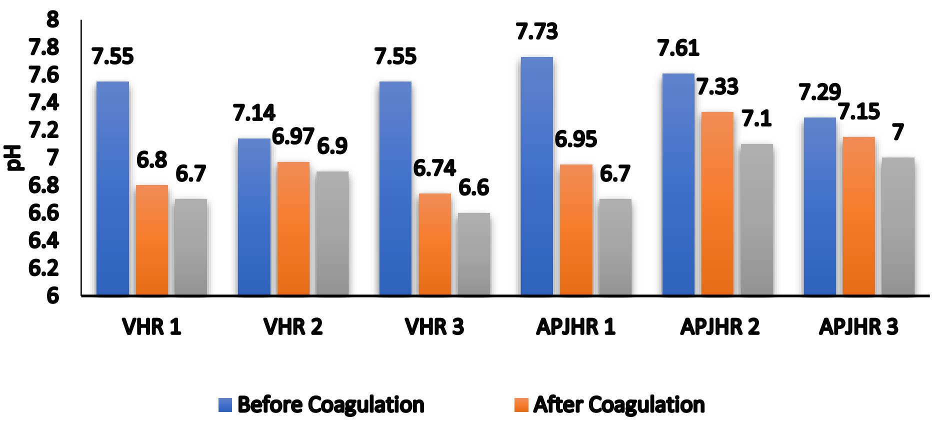

Fig. 2. pH results at every stage of treatment

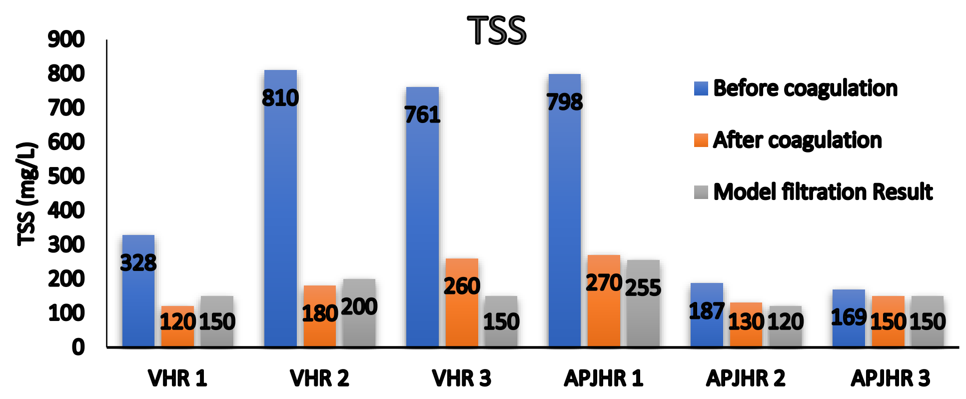

Fig. 3. TSS results at every stage of treatment

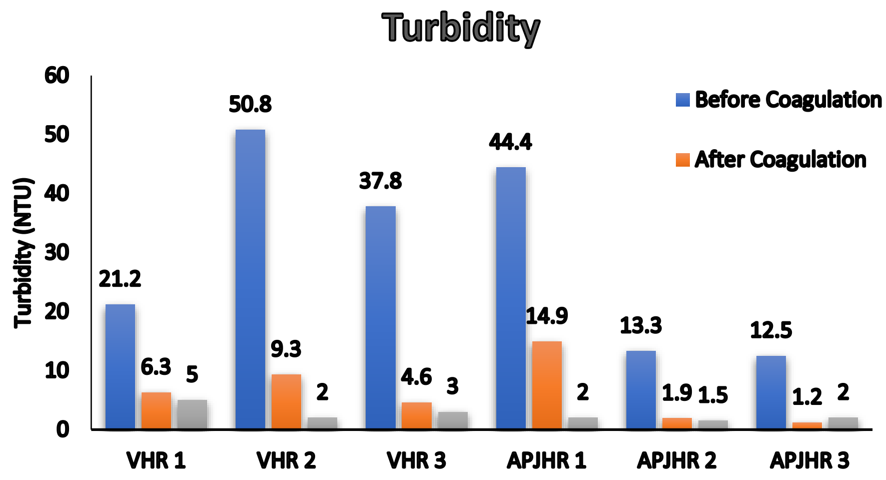

Fig. 4. Turbidity results at every stage of treatment

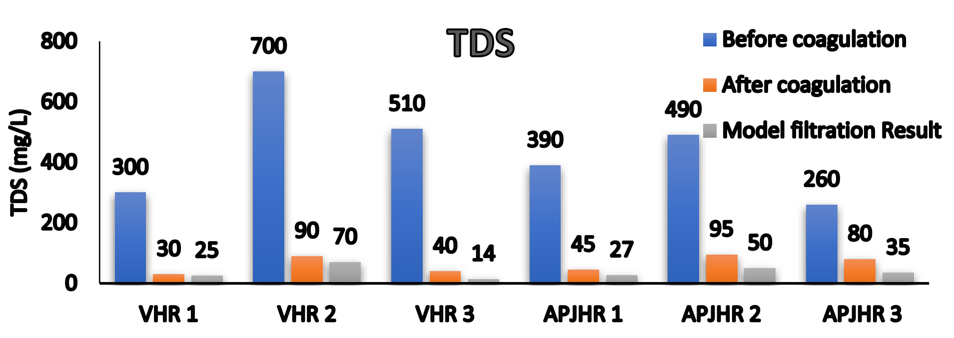

Fig. 5. TDS results at every stage of treatment

4 Conclusion

In this research, the implications of the present work demonstrate the feasibility of reutilization of greywater from hostels on the GCEK campus, highlighting a better water management solution. The greywater characterized by significant suspended solids, requires effective treatment to meet reuse standards. Application of a natural coagulant, moringa olifera seed powder was found to be efficient in reducing turbidity, while an activated carbon filter further aided in removing total suspended solids (TSS). These treatment processes ensure the greywater is suitable for non-potable utilities including landscape irrigation and toilet flushing. The study shows the importance of recommending proper treatment and monitoring to meet water quality with IS10500:2012such that the viability of reutilization of grey water. According to the WAWQI assessment, grey water from every stage of treatment from both hostels were improved from category E to category A which indicate water coming from model has ability to use for domestic purpose. This approach supports sustainable water use practices, limited dependence on fresh water and mitigating environmental impacts through disposal of wastewater.

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