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Case Study on Coconut Shell (Activated Carbon) and Neem Leaf by Using Filtration Method

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ABSTRACT

This study develops a low-cost water filtration system using coconut shells and neem leaves to improve water quality in rural areas. The filtration process follows the model, confirming the neem leaf's efficiency as an economical and effective solution for wastewater treatment. The results indicate that coconut shell-based filtration significantly improves water quality, making it suitable for non-potable applications like irrigation, flushing, and groundwater recharge. At the same time, Neem leaf showed the best pollutant removal results. The findings highlight the effectiveness of natural materials in providing affordable, eco-friendly water treatment solutions, especially for rural areas, and highlight the potential of coconut shell as an environmentally friendly alternative to chemical coagulants as a practical solution for clean water. Finally, an experimental setup is established to test the filter's efficiency by measuring water quality parameters and flow rate before and after treatment as per the required test. Results indicate that the filtration process not only significantly upgraded water quality and extremely reduced contaminants, but also consistently guaranteed adherence to rigorously established water quality standards.

Keywords: *Coconut shell (activated carbon), Neem leaf, filtration, Media filter, Water test*

1.INTRODUCTION

Water pollution is an important global problem that has serious risks to public health and the environment. As freshwater resources become rarer, effective and durable water treatment methods are in high demand. A promising solution is to use carbon activated for filtration of water. More specifically, the activated carbon derived from coconut shells and Neem leaves has drawn attention to its potential efficiency in purifying water. This introduction aims to analyze the effectiveness of these two natural adsorbents by comparing their purification effectiveness, their environmental impact and their economic feasibility. Research has shown that the activated carbon of coconut shells and Neem leaves can effectively remove pollutants such as fluoride and heavy metals from contaminated water sources (Mohan, Singh and Singh, 2008; Chukka et al., 2022). Carbon activated derived from the coconut shell has been particularly noted for its high adsorption capacity and its ability to eliminate organic products, which are common contaminants in industrial and domestic wastewater (Rangari and Chavan, 2017). Adsorption kinetics and carbon isotherms activated by Neem sheets have been sought, providing valuable information on its adsorption mechanisms (Kumar, Gupta and Yadav, 2008). Although coconut shells and Neem leaves produce effective activated carbon, the choice between the two may depend on specific water contaminants which must be treated. Carbon production methods activated from these sources can be relatively simple and inexpensive, making them options accessible for community water treatment solutions. In particular, the results of various studies highlight the way in which local materials can mitigate the burden of costly and less durable commercial water treatment methods (Kumari and Annamareddy, 2020).

While the demand for clean water continues to increase, the effective use of carbon activated from different natural sources is derived not only from its efficiency but also of the environmental and economic advantages it presents. Community level applications with these materials can lead to lasting water solutions that allow local populations to solve their water quality problems independently. Continuous research on the efficiency of purification, the environmental impact and the economic aspects of these activated carbon will further improve their role in lasting solutions for water treatment.

2.LITERATURE REVIEW

In this study purification of the water is crucial to maintain human health and protect the environment. Various natural materials have been explored for their ability to filter and purify water. Two of these materials showing promises are the carbon and Neem leaves activated by coconut shell.Several studies have confirmed its effectiveness in removing pollutants from water. Mohan, Singh and Singh (2008) have shown that carbon activated by agricultural by -products, including coconut shells, can efficiently treat waste water. Their case of study highlighted the low-cost advantage of the use of this material. In addition, Rangari and Chavan (2017) also reported promising results in preparation and performance of carbon active by coconut shells, detecting its wide surface which helps considerably in removing contaminants. On the other hand, Neem leaves have an ecological alternative for water purification. Neem leaf is known for its natural properties that can be used in adsorption processes. Sahu et al. (2023) underlined the promising results of the use of active carbon based on Neem leaves for the removal of the blue of methylene from the water. Their study highlighted kinetics, isotermes and thermodynamic aspects of the adsorption process, confirming Neem's effectiveness in the treatment of water.This discovery was echoed by Babu and GUPTA (2008), which highlighted the effectiveness of the neem leaves activated in the adsorb arise by the water. Comparative studies, such as that of Majithiya, Yadav and Tawde (2013), reveal how Neem leaves can be competitive with traditional active carbon, making them an adequate alternative in various applications. The efficiency of these natural adsorbents is supported by data on various contaminants. Chukka et al. (2022) They focused on the removal of fluorine using active carbon adsorbent and have discovered that both coconut coal and derived from Neem can reach significant removal rates. This aligns with the results of Tsamo et al. (2019), which underlined the importance of understanding both the isotermes and the kinetics in the evaluation of the efficiency of removing pollutants. The continuous research and development in this area promise to improve their effectiveness and guarantee environmental sustainability in water treatment processes. Therefore, further research on the optimization of these natural materials will provide insights on larger applications and will contribute positively to environmental management. The porous structure and the high surface of the CSAC contribute significantly to its ability to remove contaminants from the water, in particular heavy metals and organic pollutants. Mohan et al. (2008) showed that the low -cost coal derived from agricultural by -products, including coconut shells, the wastewater treated effectively, showing high removal efficiency for various contaminants. In addition, Patel (2020) and Priyadharshini and Soundhirajan (2021) support the idea is an effective agent for the removal of heavy and chrome metals from industrial effluents. The results indicate that both the activations of the coconut shell and the Neem leaves are effective, although with variable efficiency based on the contaminants involved. Arbon applications active by coconut shells and Neem leaves are crucial to deal with the global water quality problems. Paul et al. (2022) underlined the use of these materials for the treatment of domestic waste water, in which the double use of Neem and Coconut skins produced promising results in the treatment of various contaminants of waste water.

3.METHODOLOGY

In this project selecting suitable natural materials, specifically coconut shell (activated carbon) and neem leaf use for filtration purpose. A filter design is then developed to optimize water flow and maximize contact with these materials. Finally, an experimental setup is established to test the filter's efficiency by measuring water quality parameters and flow rate before and after treatment as per required test. Following process was conducted in project

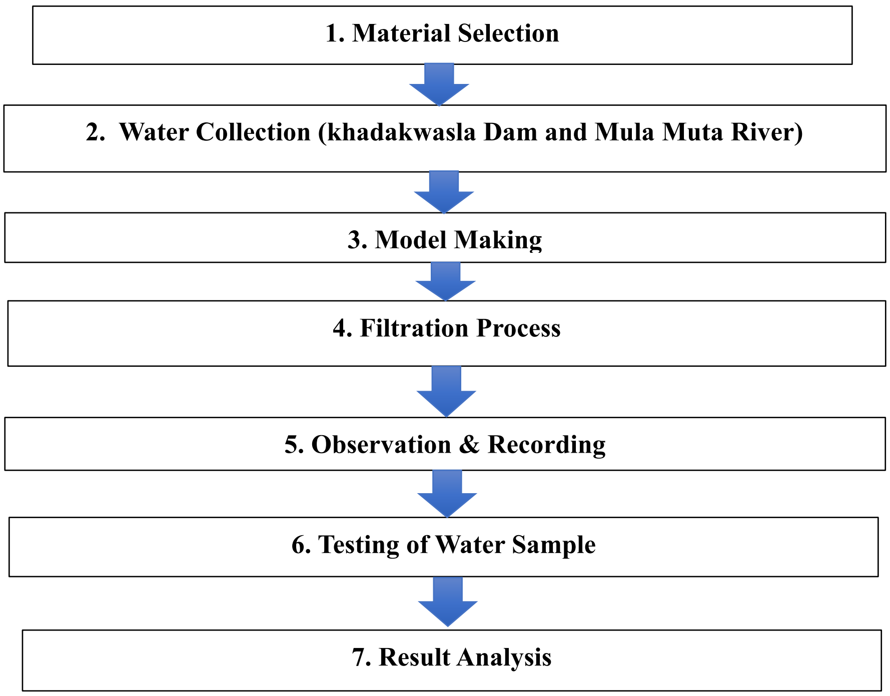


Fig. 1 Work flow of water filtration process

3.1 Material selection

The first step involves material selection, where coconut shell (activated carbon) and neem leaf are chosen due to their natural adsorption abilities and availability and next, the design of the filter focuses on creating a structure that allows water to pass efficiently through these materials, ensuring maximum contact time for effective filtration. Lastly, the experimental setup and testing phase involves constructing the filter and conducting experiments to evaluate its performance. This includes measuring key water quality parameters such as turbidity and pH, as well as determining the flow rate to assess how well the filter purifies water under different conditions.

Gravel is commonly used as a filtration medium in water treatment systems. It acts as a physical barrier that helps remove larger particles, sediments, and suspended solids from water.

Gravel is usually placed as one of the bottom layers in a multi-layer filter setup, beneath finer materials like sand and activated carbon.

Its primary role is to support the upper filtration layers, prevent clogging, and maintain proper water flow through the filter. The size and type of gravel can influence the filter's efficiency and flow rate, making it an important material in the overall filter design.

Following is some another natural materials selection for filtrations purposes

i. **Water Container: -** (20 lit Jar) 20-liter water filtration jar serves as an efficient and cost-effective solution. This system relies on multi-layered filtration to remove impurities, enhance water quality, and make it safe for consumption. A gravity-based filtration system in a water jar uses natural force (gravity) to push water through different layers of filters without requiring electricity.

ii. **River Gravel: -** Gravel is commonly used as a filtration medium in water treatment systems. It acts as a physical barrier that helps remove larger particles, sediments, and suspended solids from water. Gravel is usually placed as one of the bottom layers in a multi-layer filter setup, beneath finer materials like sand and activated carbon. The size and type of gravel can influence the filter's efficiency and flow rate, making it an important material in the overall filter design.

iii. **Sand: -** Fine river sand feels quite like washed sand, while coarse river sand has a fine, yet pebbly, feel. Generally, both will be darker than sharp or washed sand and they have a very mixed particle size Approximant 0.075 to 0.42 mm. Coarse River sand is used as a paving base. When viewed in close-up the granules of river sand are distinctly rounded. Fine sand is a filter media used in ideal pre-treatment process for water containing waterborne parasites, bacteria and suspended solids that cause turbidity, color, taste and odour. It is effective at treating groundwater with high iron and dissolved gases

iv. **Aggregate: -** irregular, angular, and sharp stones that are produced by crushing larger aggregate. Aggregate has a higher surface area and roughness than pea gravel, which makes it more effective at trapping particles and bacteria. Aggregate is usually Approximate 4.75mm & 20 mm in diameter.

v. **Neem leaf: -** A low-cost adsorbent that can be used to remove COD from water. Neem leaf powder can also be used to remove fluoride from water. From the physical analysis, study identified that when adding plants, turbidity always increases. The evaluation of chemical properties (pH, Chemical oxygen demand and biological oxygen demand) and bacteriological analysis (Coliform) shows that Neem is a better choice for water purification

vi. **Coconut shell (Activated Carbon):-** A good form of activated carbon for water filtration because it has a high density of micro-process and a large surface area. The activated carbon in coconut shells pulls contaminants to its surface and into its pores, leaving behind pure water.

vii. **Media Filter: -** In this project filter media made from cotton with cloth and it can be used as a filter media in water treatment for various purposes, including removing suspended solids, bacteria, and other pollutants. It's a cost-effective and willingly available option for simple filtration, especially in resource limited time periods.

3.2 Design of the Filter

The design of the water filter begins with thoroughly cleaning the 20-liter jar to remove any contaminants. A layer of gravel is placed at the bottom to trap large particles and support the filter structure, followed by a layer of clean sand that captures finer sediments. A media filter or fine mesh is then added to separate the layers and prevent mixing. The primary filtration layer consists of activated carbon made from coconut shells, which may be combined with dried neem leaves to enhance purification by adsorbing impurities and chemicals. Once all layers are properly arranged, the jar is sealed or fitted with a lid that allows water to flow through safely. Finally, a clean collection container is positioned to gather the filtered water, completing the setup for effective water purification.

The filter is constructed with multiple carefully arranged layers to maximize purification. At the very bottom, a media filter made of cotton covered with cloth (about 0.5 cm thick) acts as a barrier to support the layers above. Above this, a fine sand layer (3.5 cm) traps small particles, followed by a layer of 4.5 mm aggregate (3.5 cm) that helps with sediment removal.

Fig. 2 Filtration Model

The filter is constructed with multiple carefully arranged layers to maximize purification. At the very bottom, a media filter made of cotton covered with cloth (about 0.5 cm thick) acts as a barrier to support the layers above. Above this, a fine sand layer (3.5 cm) traps small particles, followed by a layer of 4.5 mm aggregate (3.5 cm) that helps with sediment removal. A 2 cm layer of activated coconut shell carbon is added next to adsorb impurities, chemicals, and improve taste and odour. Then, a 10 mm aggregate layer (3.5 cm) is placed to aid filtration, followed by another fine sand layer (3.5 cm) for capturing finer sediments. The sequence continues with another 4.5 mm aggregate layer (3.5 cm) and a second 2 cm layer of activated carbon for further purification. A 3.5 cm layer of neem leaves is included to remove bacteria and enhance water purification. Finally, the filter is topped with a 3.5 cm layer of coarse gravel, which facilitates drainage and prevents large particles from clogging the system, ensuring smooth water flow.River for analysis and testing. Khadakwasla Dam, located near Pune, is a major source of drinking and irrigation water for the city and surrounding areas. The Mula-Mutha River is formed by the confluence of the Mula Mutha rivers and flows through urban Pune, often affected by pollution due to domestic and industrial discharge. Water collected from these two sources can vary significantly from Khadakwasla water, while Mula-Mutha may contain higher levels of contaminants.

3.3 Water Filtration and Testing Process:

After collecting water samples from Khadakwasla Dam and the Mula-Mutha River, the water was passed through a specially designed natural filtration model. This model consisted of layered materials such as gravel, fine sand, coconut shell activated carbon, and neem leaves, selected for their natural purification properties. The primary goal was to remove impurities, turbidity, foul odor, and bacterial contaminants. Before filtration, the water samples were tested to determine their initial physical and chemical parameters. After passing through the filtration system, the treated water was tested again to measure improvements in water quality. This comparison helped evaluate the effectiveness of the filter in purifying both relatively clean and heavily polluted water sources.

Fig. 3 Sample filtrations process

3.4 Experimental Setup and Testing

The experimental setup involved assembling a multi-layer water filtration system using natural materials such as gravel, sand, coconut shell activated carbon, and neem leaves. A clean 20-liter plastic jar was used as the main container for the filter. Each filtering layer was carefully added in a specific order to ensure maximum purification efficiency. Water samples collected from Khadakwasla Dam and the Mula-Mutha River were poured into the filter system. Before filtration, the raw water samples were tested for various parameters such as pH, turbidity, hardness, odor, and presence of contaminants. After filtration, the same parameters were tested again to evaluate improvements in water quality. The results were compared to assess the efficiency of each layer and the overall effectiveness of the filtration system in treating water from different sources.

4.RESULTS & DISCUSSION

The test report from KULKARNI LABORATORY & QUALITY MANAGEMENT SERVICES LLP (KLQMS) evaluates multiple water samples taken from Khadakwasla dam and Mutha river, Pune and analyzing their physical, chemical, and microbiological quality. Parameters are test such as turbidity, TDS, pH, and microbial count were tested using IS 3025 and IS 1622 methods.
Table No. 4.1 provides a comparative evaluation of Khadakwasla dam and Mutha river water samples test the before after filtration process, highlighting variations in physical, chemical, and microbiological parameters.

Table No. 4.1 Sample test result from laboratory

Sr. No	Test Parameter	Khadakwasla Dam Water		Mutha River Water		IS CODE USED
		Before Filter Testing	After Filter Testing	Before Filter Testing	After Filter Testing	
01.	Turbidity, NTU	0.5	0.1	0.1	0.1	IS 3025 P:10
02.	Chloride (CL), mg/lit	3	2	13	14	IS 3025 P:32
03.	Total dissolved solid, mg/lit	53	296	379	306	IS 3025 P:16
04.	Total Hardness, mg/lit	53.2	67.7	285.5	237	IS 3025 P:21
05.	Alkalinity, mg/lit	9	9	27.2	27.2	IS 3025 P:23
06.	pH	7.9	7.4	7.3	7.9	IS 3025 P:11
07.	Calcium as CaCO3, mg/lit	38	34	32	36	IS 3025 P:40
08.	Colour, Hazen	02	01	03	01	IS 3025 P:4
09.	Odour	Agreeable	Agreeable	Agreeable	Agreeable	IS 3025 P:5
10.	Microbiological Analysis Total plate count	1.6 cfu/ml	0.33	2.3	0.8	IS 1622

Chart No.1 Khadakwasla Dam Water shows variations in several water quality parameters before and after filtrations. Improvement in turbidity is obvious and decreasing from 0.5 to 0.1 NTU, indicating improved water clarity after filtration. Likewise, the colour was improved from 2 to 1 Hazen units and the odour remained acceptable. A particularly significant transformation is observed in the reduction of microbiological contamination, with the total plate count decreasing from 1.6 to 0.33 cfu/ml, reflecting increased microbial safety. However, a substantial increase in total dissolved solids (TDS) was recorded, rising from 53 to 296 mg/lit, and total hardness increased from 53.2 to 67.7 mg / lit, possibly due to mineral release or concentration by the filter. Other parameters, such as chloride and calcium, exhibited minor variations, while alkalinity remained constant at 9 mg/lit. The pH decreased slightly from 7.9 to 7.4, yet persisted within allowed limits. Overall, the chart shows that filtration considerably improved the visual and microbiological quality of the water, although accompanied by an increase in mineral content.

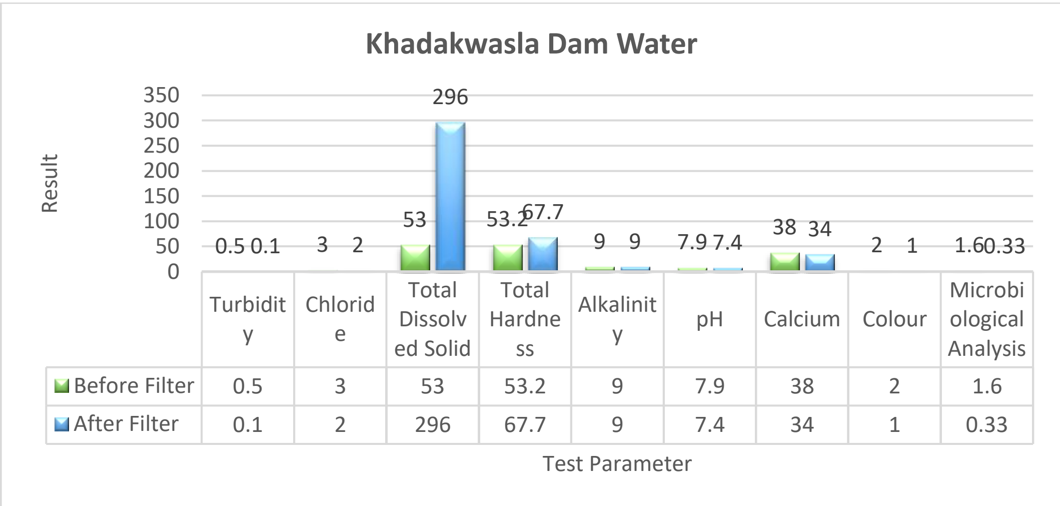
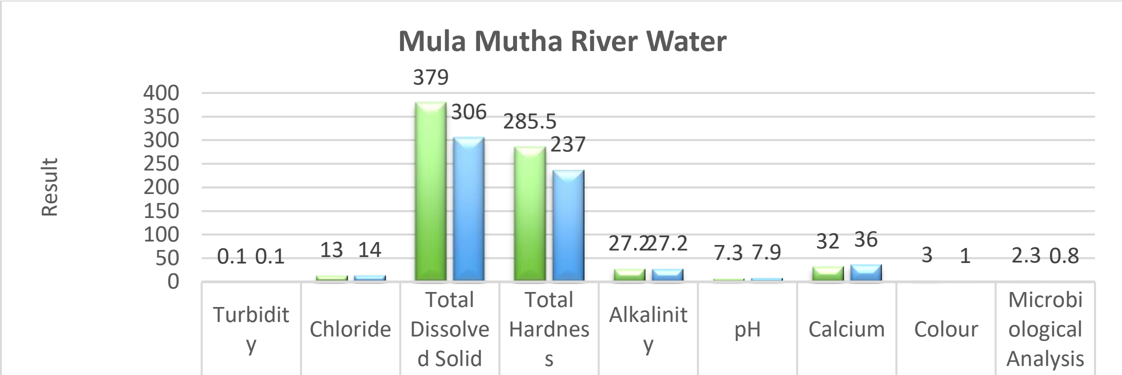


Chart No. 1 Khadakwasla dam water test results

Chart No. 2 Mula Mutha river shows variations in several water quality parameters before and after filtrations. Turbidity was consistently maintained at level of 0.1 NTU both before and after filtrations and suggesting that the water was pre-existingly clear. A slight increase in chloride concentration was recorded (from 13 to 14 mg/l), whereas the total dissolved solids (TDS) exhibited a significant decrease from 379 to 306 mg/l, indicating the effective removal of certain dissolved substances. Reduces the total hardness from 285.5 to 237 mg/l and it indicates that filtration simplified water softening. Alkalinity remained unchanged at 27.2 mg/l, while the pH level improved from 7.3 to 7.9, corresponding more closely to neutrality. The calcium concentration increased from 32 to 36 mg/l and attributed to mineral exchange during the filtration process.

Aesthetic parameters, such as color, demonstrated significant improvement, with measurements decreasing from 3 to 1 Hazen units, while the odour remained pleasant. Notably, microbiological quality showed enhancement, with the total plate count decreasing from 2.3 to 0.8 cfu/ml, indicating improved microbial safety. Overall, the filtration process yielded considerable advancements in the chemical, physical, and microbiological quality of the Mula Mutha river water.



	Turbidity	Chloride	Total Dissolved Solid	Total Hardness	Alkalinity	pH	Calcium	Colour	Microbiological Analysis
Before Filter	0.1	13	379	285.5	27.2	7.3	32	3	2.3
After Filter	0.1	14	306	237	27.2	7.9	36	1	0.8

Chart No. 2 Mula Mutha water test results

CONCLUSIONS

The KLQMS test report evaluates multiple water samples from khadakwasla dam river and Mula Mutha river analysing were tested using the IS 3025 and IS 1622 methods. In this study are that the filtration process is effective in improving the physical, chemical, and microbiological quality of water samples from Khadakwasla dam and Mutha river, Pune. However, the filtration process also resulted in increased mineral content in the Khadakwasla dam water, while simplifying water softening in the Mula Mutha river water.

1. The results showed in water quality post-filtration and reduction in turbidity to 0.1 NTU fixed with affected in microbial counts.
2. Every accurately analyzed water sample showed that it is not only acceptable odour and low colour units but also a outstanding improvement in aesthetic demand.
3. To conclude, the filtration processes not only significantly upgraded water quality and extremely reduced contaminants, but also consistently guaranteed adherence to rigorously established water quality standards.

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