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A Review On Water Purification Using Low-Cost Natural Filtration Materials Integrated With Solar Power

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ABSTRACT:

Providing access to clean and treated water remains a formidable challenge in numerous rural areas devoid of centralized water treatment systems. This review concentrates on cost-effective methods for water treatment in such rural locations where centralized water systems are absent. As per statistics from UNICEF and the WHO, a staggering one in three individuals globally, equivalent to 2.2 billion people, faces the daunting reality of lacking access to safe drinking water. The consequences of this scarcity are severe, with over 3 million people succumbing annually to waterborne diseases, including 1.3 million children under the age of six, emphasising the urgent need for effective water treatment solutions. Emphasising the importance of clean water, the review introduces low-cost purifiers for rural communities using natural materials. These aim to remove contaminants such as Alkalinity, Turbidity, Hardness, Dissolved Solids, pH, etc. The review contributes to discussions on accessible water purification to improve life quality in rural areas.[1][2]

INTRODUCTION

Securing clean water is crucial for maintaining good health, yet many rural areas face significant challenges due to the absence of sophisticated water treatment systems found in cities. Based on information provided by UNICEF and the World Health Organization, a significant portion of the global population, including many children, faces the challenge of inadequate access to safe drinking water. Alarming statistics reveal that annually, more than 3 million individuals, including 1.3 million children below the age of six, suffer from illness or succumb to the consumption of unsafe water.

This review aims to discuss uncomplicated and economical methods to ensure water safety, particularly in rural areas. By analysing data from UNICEF and the World Health Organization, we aim to comprehend the specific challenges faced by these communities and devise practical solutions.

Emphasising the paramount importance of clean water, we introduce low-cost water purifiers designed for rural locations. These purifiers utilise natural materials to cleanse water, addressing concerns such as Alkalinity, Turbidity, Hardness, Dissolved Solids, and pH. We not only identify the problems but also propose tangible solutions to enhance the lives of people in rural areas.

In our exploration of this subject, we also consider how solar power, derived from the sun, can contribute to sustainable water treatment, particularly in areas lacking electricity. In the subsequent sections, we delve into various straightforward methods for home water treatment, evaluate their efficacy, and propose innovative ideas to further improve water treatment in the future.

LITERATURE REVIEW

1. Jodelle Odover, Kathleen Nazara, Jenny Rose Saenz, and John Patrick Ruiz (2016) researched to determine the effectiveness of Moringa Coco Bamboo in purifying water. The study aimed to identify significant differences between the control and experimental groups in terms of total and coliform bacterial counts and acidity through microbiological tests. Moringa Coco Bamboo helped reduce the pH of 5 out of 9 water samples within the range of 6.5 to 8.5.[3]
2. Ajaybhaskar Reddy, et al. (2020) undertook a research study focusing on the utilisation of locally and naturally available materials for water purification intended for domestic and drinking purposes. The materials employed in the study comprised fine sand, rice husk, charcoal, pebbles, aggregate, and cotton. The primary objective of the project was to address the requirements of rural households unable to afford conventional water purifiers.[4]

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3. Sourav Kumar Ghosh, Md. Mamunur Rashid, et al. (2020) researched to develop a solar water purifier as an advancement of the current water purification systems. This innovative system utilises solar power as its energy source, storing it in a battery, which is a free and sustainable energy source. Subsequently, this stored energy is employed to power a low-cost heating coil, raising the water temperature to a specific level (below boiling temperature). Following this, the cooled water undergoes further purification through filtering chalk. The entire process is optimised using a metaheuristic approach for the heating, cooling, and purifying processes. The purified water quality was tested against various parameters, revealing that while the purification system may not significantly impact pH values, it effectively decreases COD, BOD values, and other relevant parameters.[5]
4. Yashwanth K S, et al. (2021), in their research, identified and highlighted diverse low-cost water treatment methods designed for application in rural areas. The array of methods encompassed Bamboo charcoal (Activated carbon), solar sterilization, distillation, chlorine filters, bone filters, everything-but-the-sink portable filters, slow sand filtration, and emergency homemade filters. The study aims to provide comprehensive insights into accessible and cost-effective water treatment options tailored to the specific needs of rural communities. Based on test results, the researchers suggest that the bio-sand filter is the most effective filter among these options for use in rural areas.[6]
5. Sidharth Sekhar, Ather Hussain, Hrishikesh Raj, Shamil G V, and Santhosh Acharya (2022) conducted experiments to assess the efficiency of a specialised water purifier made from corn cob. This innovative purifier is designed to address the purification needs of contaminated water in rural regions. It effectively treats greywater by utilising both regular corn cob and activated corn cob, determining its suitability for various reuse purposes such as washing, watering, and irrigation. Additionally, by extending the detention time, it becomes easier to produce an effluent that can also be utilised for drinking purposes.[7]
6. Sandesh Kedar, Shubhangi Bodke, Ajay Tawale, Saurabh Singh Yadav, and Prof. Rachana K. Vaidya (2022) aim to present a range of low-cost water filtration materials that are both effective and efficient in purifying water without being excessively expensive. These filtering materials can replace sand filters, which require more space, time, and maintenance, with filters that are more space-efficient and easier to maintain. The study explores filters such as coconut shells, charcoal, brick powder, wood powder, cactus powder, pine bark powder, seeds of the Moringa oleifera plant, calyx of hibiscus sabdariffa, leaves of Corchorus tridens, and other affordable filtration materials. These materials enhance water filtration, resulting in purer treated water and a lower overall cost of obtaining usable water.[8]
7. Shemeera K.H, K Prudhvi Raj, and K. Prathyusha (2023) assessed groundwater quality in a rural area near Vijayawada. The study focused on various physico-chemical parameters such as colour, turbidity, odour, total dissolved solids, pH, fluoride, alkalinity, iron, hardness, chloride, and magnesium to determine water suitability for drinking. Two samples were collected—one from a high school and another near Poranki Road in the village—both sourced from Nidamanuru village near Vijayawada city in Andhra Pradesh before any filtration. The researchers used charcoal, gravel, and sand as filter media to ensure water quality remained within permissible limits for chloride, alkalinity, total hardness, dissolved solids, suspended solids, pH, magnesium, nitrate, fluoride, and calcium.[9]
8. Andżelika Domo´n, Dorota Papciak, and Barbara Tchórzewska-Cie´slak (2023) evaluate and compare the effectiveness of different water purification technologies in maintaining water quality stability from the production to the point of consumption. The researchers examined the effectiveness of two technological systems: groundwater treatment processes, which encompass the following process like aeration, coagulation, sedimentation with filtration, and disinfection, in comparison to an extended treatment method involving biofiltration on granulated activated carbons (GAC). They aim to produce stable water that meets sanitary safety standards and exhibits a reduced risk of biological instability or aggressive properties, ensuring water safety from its source to the tap.[10]
9. Barecha Dandesa, Desalegn Abdissa Akuma, et al. (2023) conducted a study to develop, design, and evaluate the performance of a point-of-use drinking water purification system. Their methodology centred on the utilization of Moringa Oleifera seeds in conjunction with scoria coagulation-filtration media. The research involved in conducting test of coagulation/flocculation and sedimentation using the jar test method in batch experiments to evaluate the effectiveness of Moringa Oleifera seeds for water treatment. The study found Moringa Oleifera seeds to be effective in treating water with various issues. The optimal results were obtained using a 35 mL/L dose of Moringa Oleifera seed coagulant, successfully removing contaminants such as PO_4^{-3}, F^-, and Fe^{+3}, and reducing turbidity. After Moringa Oleifera seed coagulation, Virgin Scoria filtration

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was effective in retaining fine particles in the treated water, addressing customer complaints.[11]

10. Asnaf Aziz, Syed Aizaz Ali Shah, Abid Hussain, Syed Talha Alam, Moeen ur Islam, and Mian Hafeez Ur Rehman (2023) conducted this research to explore and evaluate the use of solar-powered technologies for purifying water, both in homes and industries. They focused on helping regions with limited resources and challenges in accessing clean water. The study aims to understand the benefits, drawbacks, and best conditions for using solar-based water purification technologies. Additionally, the researchers want to contribute to global efforts to provide clean water, incorporate renewable energy, tackle climate change, and promote sustainable development. The ultimate goal is to use solar energy to create long-lasting solutions for water shortages, maintain a balanced environment, and improve community well-being.[12]
11. Ajinkya Ravindra Telgote and Satish S. Patil (2023) This review explores diverse water treatment technologies employing waste materials such as coconut shells, banana peels, peanut shells, pomegranate peels, lemon peels, moringa oleifera seeds, peanut shells and rice husk ash for activated carbon and ash production. These materials effectively remove physical, chemical, biological, and heavy metal contaminants from water. The methods are cost-effective, environmentally safe, and locally available, showcasing versatility and sustainability in water purification. Researchers have demonstrated the efficacy of these approaches across a range of water quality parameters.

CONCLUSION

The review emphasises the urgent requirement for diverse, affordable, and context-specific water purification technologies in rural areas. From Moringa Oleifera to solar-driven systems, the studies showcase the effectiveness of locally available materials, promoting sustainability and community empowerment. The integration of renewable energy sources, particularly solar power, emerges as a promising solution for addressing water challenges in regions with limited access to electricity. The focus on public health, adaptability, and contributions to global sustainability goals collectively calls for continuous research and innovation in developing effective, accessible, and environmentally conscious water treatment solutions for rural communities.

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