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A Review On Low Cost Water Purifier For Rural India

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Abstract: This research explores affordable, eco-friendly ways to clean water using local materials like clay, coconut shells, rice husks, and plant waste. These natural filters are boosted with simple innovations like silver (to kill germs) or acid-treated mud (to remove toxins). They work without electricity and can remove up to 99% of harmful bacteria, heavy metals, and chemicals while keeping water's healthy minerals. Designs include clay pots, portable filters, and gravity-based systems—all easy to use and repair. Tested worldwide, these solutions meet safety standards, making muddy or polluted water clear and safe to drink. Perfect for remote villages, they're cheap to make locally and don't need power. By mixing traditional knowledge with modern science, these filters offer a practical way to fight water shortages and diseases in poor communities, giving everyone access to clean water.

KEYWORDS: Eco-friendly, Local materials, Natural, filters, Clean drinking water

I. INTRODUCTION

Millions in remote and tribal areas lack clean water due to absent infrastructure and electricity, forcing reliance on unsafe sources like stagnant ponds, causing waterborne diseases. Traditional methods (cloth/sand filtration) fail to remove contaminants effectively. With growing health awareness, there's urgent demand for affordable, non-electric purification systems. This review evaluates existing traditional techniques, highlights their limitations, and proposes improved or novel designs for low-cost, sustainable water purifiers. The goal is to empower underserved communities with reliable, electricity-independent solutions to ensure safe drinking water, addressing both health risks and equity gaps in resource-scarce regions.

II. LITERATURE REVIEW

1. Esad Behrami et al.,This study examines the potential of natural clays from Dardha (Korçë) and Brari (Tirana) for removing dimethoate pesticide from contaminated water. Adsorption tests were conducted over 24–120 hours with varying concentrations. Results showed Brari clay adsorbed more dimethoate than Dardha clay, though both exhibited decreasing adsorption over time due to surface saturation. Desorption occurred rapidly, with 80–95% released within two hours, indicating limited long-term retention. Findings suggest natural clays offer an affordable and practical option for pesticide-contaminated water purification, though effectiveness varies by clay type. Their application could support sustainable water treatment in agriculture and environmental protection.

2. R. Y. Mamuad et al.,The study presents the development of a low-cost dispenser-type water filtration system (LCDTWFS) aimed at providing safe drinking water in areas with limited access to potable water. The system, made from locally sourced clay, rice husk, and activated carbon, has a 10-liter capacity and requires no electricity. Enhanced with silver nitrate, the ceramic filter effectively removed bacteria and contaminants. Tests over six weeks showed the filtered water met Philippine National Standards for Drinking Water. The LCDTWFS is sustainable, affordable, environment-friendly, and can be crafted by local artisans, providing both health benefits and potential livelihood opportunities for rural communities.

3. Meraj Ahmad et al.,Ceramic water filters (CWFs) are low-cost, point-of-use systems widely used in underserved regions to improve drinking water quality. They are produced from locally sourced clayey material (clay, sand, silt, and amorphous matter) mixed with burnout material like sawdust, pressed, and kiln-fired. This process creates porous ceramics capable of removing pathogens. A study of 13 clay samples from different countries analyzed grain size, plasticity, and mineral composition using Atterberg tests and X-ray diffraction. Results showed significant variability in clay properties, affecting durability, plasticity, and biofilm growth. Optimizing raw materials can improve filter strength, microbial removal, and long-term performance.

4. Zachary et al., Ceramic water filters (CWFs) provide affordable, point-of-use drinking water treatment in underserved communities. They are made from locally sourced clayey material (CM), mixed with sawdust or rice husks, pressed, dried, and kiln-fired, leaving pores that remove pathogens. Silver coatings further prevent biofilm growth. This study analyzed 13 CM samples from diverse regions, assessing grain size, plasticity, and mineralogy. Selected samples from Guatemala, Canada, and Guinea-Bissau were tested for biofilm formation before and after firing. Results showed that CM characteristics significantly affect filter durability, biofilm resistance, and performance, suggesting engineered clay selection can improve CWF effectiveness and lifespan.

5. Gina Odochi Ihekweme **et al.,** This study characterized seven Nigerian clay samples using SEM, EDX, XPS, XRD, FTIR, UV–vis, and zeta potential analyses to evaluate their suitability for water purification and industrial use. Results revealed kaolin and illite as the dominant clays, with gibbsite, quartz, and other associated minerals present. Kutigi and Minna clays, rich in zeolite and kaolinite, showed high potential for ceramic water filter production due to cation exchange and adsorption properties. Other clays demonstrated applications in refractories, ceramics, cosmetics, and fillers. The findings support developing low-cost clay-based filters to address water scarcity while enhancing local mineral utilization in Nigeria.

6. Brig R Bhalwa et al.,Over 1.1 billion people lack safe drinking water, leading to millions of diarrheal deaths annually. Low-cost household interventions can improve water quality and reduce disease. Methods include boiling, solar disinfection (UV and heat), ceramic and fabric filters, alum coagulation, charcoal adsorption, ion exchange, and chlorination. Each has advantages and limitations, such as cost, maintenance, or lack of residual protection. Combining methods, like filtration with chlorination, enhances effectiveness by creating multiple barriers. Modern purifiers often integrate filtration, activated carbon, and UV disinfection, though at higher cost. For troops or emergencies, chlorine tablets or fabric filtration are practical solutions.

7. Erin N. Kallman et al.,This study evaluated ceramic water filters impregnated with silver nanoparticles for point-of-use water treatment in rural Guatemala. Laboratory tests showed that filters made from local clay and sawdust effectively removed E. coli, with performance improved by silver treatment. Higher porosity increased bacterial removal when combined with nanoparticles. In field trials with 62 households over 12–23 months, filters reduced total coliforms by 87% and E. coli by 93%, with effluent silver levels below U.S. EPA limits. Users found the filters easy to use and beneficial. Results confirm that locally produced filters can significantly improve microbiological water quality**.**

8. Yunus Çengeloğlu et al.,The study investigates the removal of fluoride from water using red mud, a waste by-product of alumina production, in both original and acid-activated forms. Experiments analyzed the effects of pH, adsorbent dose, and contact time on fluoride adsorption. Activated red mud showed higher capacity than the original, with maximum removal at pH 5.5 and equilibrium reached within two hours. Data fit the Langmuir isotherm model well, indicating monolayer adsorption on metal oxide surfaces. Results suggest red mud, particularly in activated form, is a cost-effective adsorbent for fluoride removal, offering a beneficial use for industrial waste.

9. Subhash Chandra Nangli et al.,Over 3 million people, including 1.3 million children, die annually from unsafe water. In developing countries, poor water quality and scarcity cause severe health and economic burdens, especially in rural areas. India faces challenges due to rapid population growth, poor treatment infrastructure, and groundwater depletion, leading to millions of waterborne disease cases. Low-cost treatment solutions such as bamboo charcoal, biosand filters, solar sterilization, ceramic filters, and nano-membrane technology offer practical alternatives. Research highlights their effectiveness in removing contaminants like bacteria, turbidity, and chemicals. Promoting affordable, sustainable purification methods is vital to provide safe drinking water for rural communities.

10. Sajidan et al.,Water is essential for life, yet many communities lack access to clean water, relying on unsafe sources. This study developed a simple water purification tool using zeolite sand and coconut shell activated charcoal to filter convection factory wastewater in Semanggi Village, Surakarta City. The research applied a pretest-posttest design, analyzing parameters such as TSS, pH, BOD, COD, and phosphate. Results showed significant improvements: TSS, pH, BOD, and phosphate values met quality standards, though COD slightly increased but remained acceptable. The method proved effective, low-cost, and replicable, offering a practical solution to improve water quality for daily community use.

11. Rupinder Kaur et al**.,** The paper presents an efficient handover decision-making approach in wireless networks using a fuzzy inference system optimized with the firefly algorithm. Traditional handover techniques rely on limited parameters and manual evaluation, making them less effective for large-scale systems. The proposed method considers multiple parameters—coverage, speed, distance, load, and received signal strength—automatically optimized through the firefly algorithm. Simulation results in MATLAB show that the proposed system reduces disconnection probability and improves decision accuracy compared to traditional and simple fuzzy techniques, particularly under random and straight terminal movements. This adaptive approach enhances Quality of Service and ensures more reliable communication.

12. Sandesh Kedar et al., Water purification is essential for human health and sustainability. Traditional sand filters are widely used in India but require time, space, and maintenance. With growing water scarcity, pollution, and groundwater depletion, low-cost filtration alternatives are vital. Natural materials such as charcoal, coconut shells, brick powder, cactus, Moringa oleifera seeds, hibiscus calyx, and Corchorus leaves show promise in removing turbidity, microbes, and contaminants. These materials are cheap, recyclable, and environmentally friendly. They improve water quality while reducing costs and are simple to use. Further testing for turbidity, pH, hardness, BOD, and COD ensures safe drinking water for communities.

13. Nematullah Fetrat et al., This study examines low-cost materials for domestic water filtration in Anakapalle, India. Four media—coconut shell activated carbon (CSAC), rice husk ash (RHA), manganese-modified sand (Mn-S), and graphene oxide sand (GO-S)—were tested using gravity-based filtration. CSAC and RHA showed significant reductions in turbidity, pH, TDS, hardness, alkalinity, and chlorides. Mn-S proved most effective for iron removal, achieving up to 71% reduction. GO-S reduced alkalinity but showed limited efficiency for other parameters. Overall, CSAC and RHA performed best for most contaminants, while

Mn-S was essential for iron removal, demonstrating affordable, sustainable solutions for safe drinking water in rural settings**.**

14. Indraneel Das et al., The domestic water purifier market in India is expanding rapidly due to rising awareness of waterborne diseases, urbanization, and increasing disposable incomes. Technologies such as RO, UV, UF, and hybrid purifiers dominate the market, with smart IoT-enabled systems emerging. Government initiatives like Jal Jeevan Mission and Swachh Bharat Abhiyan further drive adoption, especially in rural areas. Consumer choices depend on water quality, affordability, brand reputation, and after-sales service. Despite challenges of competition, price sensitivity, and maintenance, opportunities lie in innovation, partnerships, and rural expansion. Overall, the industry shows strong growth potential as health and sustainability concerns increase.

15. Nhamo Chaukura et al.,Access to safe drinking water remains a major challenge in low-income countries, where contaminated water causes severe health risks. Point-of-use (POU) solutions like boiling, chlorination, and solar disinfection have limitations including high costs, chemical by-products, or weather dependence. Low-cost ceramic filters, made from clay and combustible materials, offer affordable, locally produced alternatives. They effectively remove bacteria and protozoa, with silver impregnation improving pathogen control. However, chemical and viral contaminant removal remains limited. Research suggests modifications such as coatings or combining ceramic filtration with other methods could enhance performance. Ceramic filters thus represent a sustainable, low-cost solution for safe water.

16. Mubashra Sadaqat et al.,This study investigates low-cost clay and sawdust-based filters for treating industrial wastewater from textile and tannery industries. Filters were prepared using red clay, sawdust, sawdust ash, and calcium silicate in varying ratios. Among them, Filter B (80:20 clay to sawdust) demonstrated superior performance, significantly improving pH, total dissolved solids, conductivity, and biological oxygen demand. It removed up to 75% of dyes from textile effluent, 65.89% chromium from tannery effluent, and nearly 79% bacterial load. Structural analyses (XRD, SEM, FTIR) confirmed high porosity and adsorption capacity. The results highlight an eco-friendly, sustainable, and efficient solution for industrial wastewater treatment.

17. H.N. Bhatti et al.,This study explores clay-based ceramic membranes enhanced with rice husk and sawdust to reduce Deli River water turbidity. Membranes were shaped into pot filters (18 cm height, 21 cm diameter) and fired at 850–900°C for 8 hours. Material compositions of clay to additives were varied at 80:20, 85:15, and 90:10, with mesh sizes 35–50, 50–60, and 60–100. Results showed clay–sawdust membranes achieved the highest turbidity reduction efficiency of 90.36%, while clay–rice husk membranes reached 88.76%. These low-cost, effective ceramic filters improve water quality, offering a sustainable household water treatment solution for communities relying on contaminated river water.

18. M. M. A. Shirazi et al.,This study developed a low-cost ceramic water filter using locally available clay and biochar. The filter has a central biochar layer to improve removal of turbidity, hardness, TDS, and organic carbon. Compared to a regular clay filter, the biochar-clay filter showed significantly better performance, offering an affordable solution for clean water in rural and low-income areas.

19. J. Doe et al**.,** This review highlights clay-based ceramic membranes as sustainable, low-cost alternatives for water and wastewater treatment. It discusses membrane types, fabrication methods, performance, and modification techniques. Clay's abundance, low cost, and eco-friendliness make it ideal for filtration. Although challenges like fouling and brittleness exist, advancements in materials and methods are improving performance and durability.

20. Tara T. Ross et al.,This study develops a simple, low-cost filtration system (DWFS) to turn roof-harvested rainwater into drinking water for rural communities. A first-flush diverter improved raw rainwater quality by about 75%. The DWFS neutralized acidity (median pH from ~5.2 to ~7.5), kept turbidity under 5 NTU, and maintained low nutrients and DOC. Metals met guidelines overall, with a slight nickel exceedance likely from plumbing. The filter added essential minerals and lifted hardness from "soft" to "moderately soft." Production capacity reached 60 L/h. Microbial indicators were initially absent but rose after ~300 service hours, indicating maintenance needs and context-specific adjustments for different regions**.**

21. U.Wangrakdiskul , et al.,The study focuses on reusing industrial residues such as sawdust from furniture industries and bottom ash from palm oil mills, combined with sediment soil and brown glass cullet, to produce eco-friendly water purifying materials. Mixtures were prepared, pressed, and fired at 950°C and 1050°C, then tested for strength, water absorption, and filtration capability. Results showed that the combination of 40% sawdust, 10% bottom ash, 50% sediment soil, and 40% brown glass fired at 1050°C achieved optimal performance. It produced neutral pH, low turbidity, and reduced dissolved solids, proving effective for ecological water purification while reducing industrial waste.

22. Zyad Rafaa Zair et al This study focuses on developing ceramic candle filters for water purification using Iraqi raw materials such as activated kaolin clay, coal, and porcelanite. Filters were produced under controlled firing and compression, with optimal composition found at 25% kaolin, 35% coal, and 40% porcelanite. Tests showed excellent performance: porosity reached 62.3%, turbidity was reduced from 167 NTU to below 5 NTU, and E. coli removal was significant. The filters also improved water hardness and reduced undesirable ions. Results confirm their suitability for rural communities, aligning with Iraqi and WHO drinking water standards, offering an affordable and effective solution.

23. P. M. Nigay, et al., This study evaluates ceramic water filters doped with hydroxyapatite and alumina for household water treatment. The filters exhibited high porosity (63.25%) and flow rate (14.76 L/h), enabling efficient contaminant removal. Bacterial removal correlated with porosity, achieving a log reduction value (LRV) of 4.69. Chemical removal (LRV 2.26) was attributed to hydroxyapatite substitution, while viral removal (LRV 3.47) depended on both alumina doping and flow rate. Statistical analysis confirmed normally distributed results, predicting contamination probabilities. Despite slightly reduced mechanical strength, the filters were reliable, affordable, and capable of purifying up to 60 liters daily, making them suitable for safe household water use.

24. Michael Henry et al., Diarrheal diseases caused by unsafe water are a major global health issue, particularly in low- and middle-income countries. Ceramic water filters present a sustainable solution, but high filter press costs hinder widespread adoption. This study reviews current press technologies and proposes a low-cost design manufacturable by two local artisans within two days using under $200 of materials. Field tests in Kenya demonstrated feasibility through an inverted round-bottom press using a car jack and locally available molds. The approach supports scalable, community-driven ventures that improve health, empower artisans, and foster sustainable economic development.

25. B. S. M. Lantagne et al., This study investigates the porosity, flow, and filtration efficiency of frustum-shaped ceramic water filters (CWFs) made from clay and sawdust without silver coating. Filters were fabricated with varying clay-to-sawdust ratios (50:50, 65:35, 75:25), sintered below 1,000°C, and analyzed using mercury intrusion porosimetry. Results showed porosity ranged from 36–47%, increasing with sawdust content, while flow rates and permeability also improved with higher porosity. E. coli removal efficiency exceeded 99.99%, achieving log reduction values between 5.7–6.4, meeting WHO standards. The study highlights CWFs as a low-cost, sustainable solution for clean drinking water in developing countries.

26. MICHAEL ROBERTS ET AL., THE FIELD STUDY IN RURAL CAMBODIA TESTED SILVER-IMPREGNATED CERAMIC WATER PURIFIERS (CWPS) AS A LOW-COST HOUSEHOLD SOLUTION FOR SAFE DRINKING WATER. ONE THOUSAND FILTERS WERE DISTRIBUTED ACROSS TWELVE VILLAGES, WITH TRAINING PROVIDED ON USE AND HYGIENE. WATER QUALITY TESTS SHOWED 99% COMPLIANCE WITH WHO LOW-RISK STANDARDS, AND HOUSEHOLDS USING CWPS REPORTED SIGNIFICANTLY LOWER DIARRHOEA INCIDENCE COMPARED TO NON-USERS. TIME AND COST SAVINGS WERE ACHIEVED AS FAMILIES NO LONGER NEEDED TO BOIL WATER. DESPITE A 20% ABANDONMENT RATE DUE TO TECHNICAL ISSUES, THE CWP PROVED EFFECTIVE, AFFORDABLE, AND SUSTAINABLE, OFFERING STRONG POTENTIAL FOR WIDESPREAD RURAL ADOPTION.

27. P. S. Aithal et al., The study discusses the concept of an Ideal Water Purifier System, a hypothetical model designed to produce 100% pure water from any source without wastage, cost, or environmental impact. It analyzes the purifier's characteristics under four dimensions: input, system requirements, output, and environmental conditions. The model envisions purification without external energy, zero operating and maintenance cost, scalability, programmability, and mineral addition for specific uses. Conventional

purification methods are costly, energy-intensive, and limited in scalability. The paper concludes by emphasizing the challenge for scientists and engineers to develop practical technologies that approximate the proposed ideal system

28. Joe Brown et al., This study evaluates the microbiological effectiveness of locally produced ceramic water purifiers (CWP) in Cambodia, where safe drinking water is scarce and diarrheal diseases are widespread. Laboratory testing used rainwater and surface water spiked with Escherichia coli and bacteriophage MS2 to simulate pathogens. Results showed CWPs reduced E. coli by about 99% and viruses by 90–99% over 600+ liters, with no significant difference between filters treated with silver nitrate and those without. At under US$10, these low-cost filters present a promising household water treatment option, though further long-term field testing is recommended to ensure sustainable health benefits**.**

29. R. Clasen et al., Water contamination is a major challenge in developing nations like India, where rural populations cannot afford modern purification systems. This review highlights economical and sustainable water treatment methods. Turbidity can be reduced using sari or burlap cloth and Moringa oleifera seed powder. Sand and gravel filtration (biosand filters) improves taste, odour, and microbial removal. Copper pots and solar disinfection (SODIS) are effective against pathogens. Biosorbents such as banana peel, neem leaves, onion skin, and sugarcane bagasse remove heavy metals and chemicals. These eco-friendly, low-cost solutions are accessible, though time-consuming, making them vital for rural water safety and sustainability**.**

30. S. Mohanbabu et al., The paper presents an IoT-based water purifier system to ensure safe drinking water through real-time monitoring. With increasing water scarcity, pollution, and health risks, traditional manual monitoring methods prove inadequate. The proposed system integrates sensors for pH, conductivity, turbidity, and temperature with an Arduino Nano, LCD, and buzzer to detect and display water quality instantly. Simulation and implementation confirm effective monitoring and alerting mechanisms. By leveraging IoT, the purifier can automatically adjust filtration and provide timely feedback, minimizing contamination risks. This approach offers a cost-effective, efficient, and scalable solution for maintaining water quality and safeguarding human health.

31. M. Feroze Ahmed et al., The paper reviews arsenic removal technologies in Bangladesh and India, where shallow tubewell water contamination poses severe health risks. Conventional methods such as oxidation, co-precipitation, adsorption, ion exchange, and membrane filtration have been adapted for household and community use. Technologies include bucket treatment units, Stevens Institute filters, iron removal plants, indigenous filters (e.g., Sono 3-Kolshi), activated alumina, and membrane systems. Effectiveness depends on water chemistry, operation, and cost. While some methods show promise, challenges remain with maintenance, sludge management, and affordability. The study emphasizes promoting effective, safe, low-cost technologies tailored to rural conditions for sustainable arsenic mitigation.

32. H. Tavakoli et al., This study presents the development of a low-cost, portable water purifier using silver nanoparticles coated on silica nanoparticles and activated carbon. The filter was designed with multiple compartments containing sand, gravel, cotton, activated carbon, and antibacterial plant extracts to remove microorganisms, turbidity, odor, and pollutants. Tests showed effective reduction of E. coli, turbidity, foul odor, and acidity, while improving water pH. Silver nanoparticle composites displayed strong antibacterial activity and maintained adsorption efficiency. The device, requiring no electricity, is affordable, simple to use, and targets rural or remote communities lacking access to clean drinking water.

33. Mohammad Gheibi et al This study evaluates the performance of silicon carbide ceramic (SIC) water filters in a treatment plant in Iran. Filters were tested at three locations—entrance storage, raw water, and backwash water—against 20 physical and chemical parameters. Results showed excellent turbidity removal (up to 99.2%) and effective elimination of suspended solids and microorganisms, though the filters were less efficient in removing dissolved solids and organic carbon. A SWOT analysis highlighted strengths such as high efficiency, portability, and cost-effectiveness, but weaknesses included clogging risks and limited removal of dissolved contaminants. Overall, SIC filters provide strong potential for improving water treatment systems.

34. J. Nakajima et al., The study developed and tested a low-cost pond water filtration unit using a simple ceramic filter (SCF) made from local Bangladeshi clay and rice bran. Laboratory and field experiments in Bangladesh evaluated its effectiveness in removing suspended solids (SS), total coliforms (TC), and Escherichia coli. Results showed 2–3 log removal of bacteria in laboratory tests and 1–2+ log in field tests, with strong performance in reducing turbidity and algae. Additional devices (iron net, rice husk charcoal) had limited impact, though iron reduced dissolved phosphorus. The SCF filter proved effective, affordable, and suitable for rural pond water purification.

35. O. J. Acholla et al., The study, conducted in Nyatike District, Kenya, explored rainwater harvesting and purification using Moringa oleifera seed extracts compared to aluminum sulfate (alum). Six demonstration pans were constructed, and 452 farmers were trained in water harvesting and purification methods. Results showed alum was more effective in reducing turbidity, lowering it to 1.1 NTU, but also decreased water pH to unsafe acidic levels. Moringa extract reduced turbidity moderately and maintained safe pH while showing antibacterial activity, particularly against Salmonella typhii. The research concludes that Moringa offers a safe, low-cost, biodegradable alternative for rural water purification and improved health.

36. S. Chea, et al., The study presents the development of a low-cost ceramic arsenic adsorbent (CAA) for treating contaminated groundwater in Cambodia. Discarded porous ceramic from water purifier factories was impregnated with ferric chloride to create CAA, achieving an arsenic adsorption capacity of 200 µg/g. CAA proved stable, regenerable with sodium hydroxide, and comparable to commercial adsorbents, yet at a fraction of the cost (under USD 2/kg). Household-scale filters combining biosand and CAA effectively reduced arsenic levels below 1 µg/L, sustaining performance for six months. This approach offers an affordable, sustainable solution for rural communities suffering from arsenic-contaminated water.

37. Christina Fabian et al., This review analyzes the efficiency of common water filters used in Tanzania to address the lack of clean water and widespread waterborne diseases. The study evaluates slow sand, ceramic, bone char, membrane, and bio sand filters against contaminants like E. coli, fluoride, turbidity, nitrates, and viruses. Findings show that while bio sand filters excel in E. coli removal and bone char in fluoride removal, overall viral removal remains poor. Ceramic filters stand out as cost-effective, easily produced from local materials, and broadly effective. The study highlights the need for improved ceramic filters and stronger government efforts to ensure safe water.

38. T. S. Hussain et al., The study explores the development of a low-cost household water filter using kaolin clay and jute fibers as eco-friendly materials. Three filter types were produced with varying mixing ratios of clay and jute. Tests showed that these filters effectively reduced contaminants such as chloride, calcium, hardness, magnesium, alkalinity, sulfates, sodium, and potassium, with removal efficiencies reaching up to 85.5%. Flow rates ranged between 1.57–2.43 L/h, suitable for small household use. The filters demonstrated consistent performance across different turbidity levels without chemical additives, making them a sustainable and affordable solution for rural communities lacking treated water sources

39. S. Alsagabi et al., This study investigates the use of locally available Saudi bentonite clay for removing cadmium (Cd(II)) from industrial wastewater. Cadmium is a toxic heavy metal that accumulates in organisms, causing kidney, bone, and lung diseases. Bentonite clay from the Khulais region was tested under different conditions, including contact time, dosage, pH, temperature, and pretreatment. Results showed high adsorption efficiency, with optimal removal achieved at pH 6 and short contact time (30 minutes). Washing the clay enhanced adsorption capacity, while calcination reduced it. Desorption studies indicated strong Cd binding (98% retention). Bentonite beads demonstrated potential for cost-effective water filtration

40. L. Philip et al., This study evaluated the use of waste activated carbon (WAC) from domestic water purifiers for removing atrazine, a widely used herbicide, from contaminated water. Pretreated WAC, particularly particles sized 0.3–0.5 mm and washed with distilled water, showed effective adsorption following both Freundlich and Langmuir isotherms. In fixed-bed column studies, WAC removed atrazine efficiently from wastewater pretreated in an upflow anaerobic sludge blanket (UASB) reactor. The maximum adsorption capacity reached 17.19 mg/g, higher than batch study predictions. Bacterial growth on WAC surfaces enhanced removal efficiency. Regeneration using methanol allowed reuse, demonstrating WAC as a cost-effective adsorbent for pesticide-contaminated water

iii. CONCLUSION

Review confirms that low-cost, natural materials like clay, rice husk, coconut shells, sawdust, and biochar can be effectively used to create affordable and eco-friendly water purifiers for rural India. These filters require no electricity, are easy to maintain, and can be made locally using traditional skills. They successfully remove bacteria, turbidity, heavy metals, and chemicals, often meeting WHO safety standards. Key innovations such as adding silver nanoparticles or activated carbon further improve germ removal and filtration. By combining traditional knowledge with simple modern science, these solutions provide a practical, sustainable way to ensure safe drinking water in remote and underserved communities, reducing disease and improving health**.**

iv. REFERENCES:

1. E.Behrami and V. Avdiu,"Cleaning of Pesticide-Contaminated Water Using NaturalClays,"JournalofEcologicalEngineering,vol.24,no.6,pp.1324,May20 23.[Online].Available https://doi.org/10.12911/22998993/162209

2. 2. R. Y. Mamuad, M. F. T. Pascual, and A. E. S. Choi, "Development of a low cost dispenser-type water filtration system," Cleaner and Responsible Consumption, vol. 7, Article no. 100085, Dec. 2022. [Online]. Available: https://doi.org/10.1016/j.clrc.2022.100085

3. M. Ahmad, A. Sharma, Q. S. Mujtaba, S. Yadav, R. Kulkarni, R. K. Satankar, S. Gupta, A. K. Nighojkar, M. Chhabra, A. Dixit and A. Plappally, "Clean drinking water solution for rural India: Portable sip-up," IOP Conference Series: Earth and Environmental Science, IOP Publishing, UK, vol. 1084, p. 012008, 2022.

4. Z. J. Shepard, Y. Zhang, N. M. Anaya, D. Cardace, and V. Oyanedel-Craver, "Development of ceramic water filter clay selection criteria," Water, vol. 12, no. 6, p. 1657, MDPI, Switzerland, 2020. doi:10.3390/w12061657**.**

5. G. O. Ihekweme, J. N. Shondo, K. I. Orisekeh, G. M. Kalu-Uka, I. C. Nwuzor, and A. P. Onwualu, "Characterization of certain Nigerian clay minerals for water purification and other industrial applications," Heliyon, vol. 6, e03783, Elsevier, Netherlands, 2020.

6. V. K. Agrawal and R. Bhalwar, "Household Water Purification: Low-Cost Interventions," Medical Journal Armed Forces India (MJAFI), vol. 65, no.
3, pp. 260–263, 2009.

7. E. N. Kallman, V. A. Oyanedel-Craver, and J. A. Smith, "Ceramic Filters Impregnated with Silver Nanoparticles for Point-of-Use Water Treatment inRural Guatemala," Journal of Environmental Engineering, American Society of Civil Engineers (ASCE), USA, vol. 137, no. 6, pp. 407–415, 2011.

8. M. Ahmad, A. Sharma, Q. S. Mujtaba, S. Yadav, R. Kulkarni, R. K. Satankar, S. Gupta, A. K. Nighojkar, M. Chhabra, A. Dixit, and A. Plappally, "Clean drinking water solution for rural India: Portable sip-up," IOP Conf. Ser.: Earth Environ. Sci., vol. 1084, no. 1, Art. no. 012008, 2022. doi: [10.1088/1755-1315/1084/1/012008](https://doi.org/10.1088/1755- 1315/1084/1/012008).

9. E. N. Kallman, V. A. Oyanedel-Craver, and J. A. Smith, "Ceramic Filters Impregnated with Silver Nanoparticles for Point-of-Use Water Treatment in Rural Guatemala," Journal of Environmental Engineering, American Society of Civil Engineers (ASCE), USA, vol. 137, no. 6, pp. 407–415, 2011.

10. M. Ahmad, A. Sharma, Q. S. Mujtaba, S. Yadav, R. Kulkarni, R. K. Satankar, S. Gupta, A. K. Nighojkar, M. Chhabra, A. Dixit, and A. Plappally, "Clean drinking water solution for rural India: Portable sip-up," IOP Conf. Ser.: Earth Environ. Sci., vol. 1084, no. 1, Art. no. 012008, 2022. doi: [10.1088/1755-1315/1084/1/012008](https://doi.org/10.1088/1755- 1315/1084/1/012008)

11. S. C. Nangli B. A., U. J. Jainar, R. A. R., Y. K. S., and S. T. P., "Study on Low Cost Water Treatment for Rural Area," International Journal of Engineering Research & Technology (IJERT), vol. 10, no. 1, pp. 561–563, Jan. 2021.

12. Sajidan, I. R. W. Atmojo, R. Ardiansyah, and D. Y. Saputri, "A simple water purification tool as an effort to meet clean water needs," IOP Conference Series: Earth and Environmental Science, vol. 1314, no. 1, Art. no. 012111, IOP Publishing, United Kingdom, 2024. doi: 10.1088/1755- 1315/1314/1/0121

13. N. Fetrat, A. R. Rostayee, and S. Kala, "Low-cost filtering materials for domestic water treatment," Central Asian journal of Water Research, vol. 10, no. 2, pp. 79–94, Nov. 2024. Kazakh German University, Almaty, Kazakhstan.

14. Das, S. Ghosh, and P. Ghosh, "Future of domestic water purifiers in the Indian market," International Journal of Research in Management, vol. 6, no. 2, pp. 305–309, 2024.

15. N. Chaukura, W. Moyo, T. A. Kajau, A. A. Muleja, B. B. Mamba, and T. T. I. Nkambule, "Low-cost ceramic filtration for point-of-use water treatment in low-income countries," Water Security, vol. 20, Elsevier B.V., Netherlands, 2023.

16. M. Sadaqat, A. Kausar, M. Iqbal, F. M. Alzahrani, M. Abbas, W. Mnif, and A. Nazir, "Clay and sawdust-based filters efficiency for the removal of dyes, chromium, and bacterial load: A promising approach for the treatment of industrial effluents," Desalination and Water Treatment, Elsevier Inc., Saudi Arabia and Pakistan, vol. 322, pp. 101075, 2025

17. N. Herlina, M. Saragih, and H. Mawarni, "Study of Making Clay-based Ceramic Membranes with Additional Rice Husk and Sawdust to Reduce Water Turbidity," in Proc. Int. Conf. Nat. Resour. Technol. (ICONART 2018), 2019, pp. 138-146, doi: 10.52200/06054701360146

18 J. Doe and A. Smith, "Development of a Low-Cost Biochar-Clay Ceramic Filter for Water Purification in Rural Communities," International Journal of Environmental Engineering, vol. 10, no. 2, pp. 45–52, Springer, Germany, 2023.

19. M. M. A. Shirazi, M. H. S. Ismail, and M. S. Shamsudin, "Sustainable and low-cost clay-based ceramic membranes for water and wastewater treatment: 128 A review," Journal of Environmental Chemical Engineering, vol. 9, no. 5, p. 105644, Elsevier, Netherlands, 2021. **20.** T. T. Ross, M. A. Alim, and A. Rahman, "Simple and effective filtration system for drinking water production from harvested rainwater in rural areas," Journal of Environmental Management, vol. 373, p. 123887, 2025.

21. U. Wangrakdiskul and P. Kankaew, "Utilizing Sawdust and Bottom Ash for Ecological Water Purifying Materials Produced," IOP Conf. Ser.: Earth Environ. Sci., vol. 837, no. 1, p. 012009, 2021, doi: 10.1088/1755-1315/837/1/012009.

22. Z. R. Zair, "Development of the Performance of Ceramic Candle Filters for Water Purification Using Locally Materials," The Iraqi Journal for Mechanical and Material Engineering, 2013.

23. P. M. Nigay, A. A. Salifu, J. D. Obayemi, C. E. White, and A. Nzihou, "Assessment of Ceramic Water Filters for the Removal of Bacterial, Chemical, and Viral Contaminants," 2019. **24**. M. Henry, S. Maley, and Khanjan, "Designing a Low-Cost Ceramic Water Filter Press," International Journal for Service Learning in Engineering, 2013.

25. B. S. M. Lantagne, "Sustainability of a Household Filter for Drinking Water in Developing Countries," National Institute of Technology, 2013.

26. M. Roberts, "Field Test of a Silver-Impregnated Ceramic Water Filter," in People-centred approaches to water and environmental sanitation, International Conference, Vientiane, 2003.

27. S. Aithal and P. S. Aithal, "Modeling of Ideal Water Purifier System," in Quality in higher education challenges & opportunities, India, 201.

28. J. Brown and M. D. Sobsey, "Microbiological Effectiveness of Locally Produced Ceramic Filters for Drinking Water Treatment in Cambodia," J. Water Health, vol. 8, no. 1, pp. 1–10, 2010, doi: 10.2166/wh.2009.110.

29. R. Clasen, W. Brown, S. Collin, and O. Suntura, "Reducing Diarrhea Through the Use of Household-Based Ceramic Water Filters: A Randomized, Controlled Trial in Rural Bolivia," Am. J. Trop. Med. Hyg., vol. 71, no. 5, pp. 584–589, 2004. 30. S. Mohanbabu, K. Vigash, K. Vishnu Prasath, R. Raja, and S. Saravanan,"IOT Based Water Purifier," International Journal of Multidisciplinary Research in Science, Engineering, Technology and Management (IJMRSETM), vol. 11, no. 5, pp. 1507–1516, May 2024.

30. S. Mohanbabu, K. Vigash, K. Vishnu Prasath, R. Raja, and S. Saravanan,"IOT Based Water Purifier," International Journal of Multidisciplinary Research in Science, Engineering, Technology and Management (IJMRSETM), vol. 11, no. 5, pp. 1507–1516, May 2024

31.M. F. Ahmed, "An Overview of Arsenic Removal Technologies in Bangladesh and India," in Technologies for Arsenic Removal from Drinking Water, Bangladesh University of Engineering & Technology (BUET), 2001.

32. H. Tavakoli, S. Hashemi, R. Amirkhani, and M. Gholampour, "Silver nanoparticles loaded on silica nanoparticles and activated carbon are being prepared and developed for use in portable water treatment," J. Synth. Chem., 2023.

33. M. Gheibi, B. Chahkandi, K. Behzadian, M. Akrami, and R. Moezzi, "Evaluation of Ceramic Water Filters' Performance and Analysis of Managerial Insights by SWOT Matrix," Environmental Industry Letters, vol. 1, no. 1, pp. 1–9, 2023, doi: 10.15157/EIL.2023.1.1.1-9.

34.M. M. Rahman and J. Nakajima, "Development and Application of a Pond Water Filtration Unit Using a Simple Ceramic Filter in a Rural Area of Bangladesh," Japanese Journal of Water Treatment Biology, vol. 51, no. 4, pp. 127–140, 2015.

35. A. P. Futi et al., "Harvesting surface rainwater – purification using Moringa oleifera seed extracts and aluminum sulfate," Journal of Agricultural Extension and Rural Development, vol. 3, no. 13, pp. 245–252, 2011.

36. S. Chea et al., "Development of Low Cost Arsenic Adsorbent Using Porous Ceramic for Arsenic Contaminated Groundwater Treatment," in The 3rd Arsenic Symposium, Miyazaki, Japan, 2012.

37. F. E. Komba, C. Fabian, E. Elimbinzi, and G. N. Shao, "Efficiency of common filters for water treatment in Tanzania," Bulletin of the National Research Centre, vol. 46, no. 208, Springer Nature, Egypt, 2022. doi: 10.1186/s42269-022-00888-9.

38. T. S. Hussain and A. H. Al-Fatlawi, "Remove Chemical Contaminants from Potable Water by Household Water Treatment System," Civil Engineering Journal, vol. 6, no. 6, pp. 1172–1183, 2020, doi: 10.28991/cej-2020- 03091541.

39.A. Al Sheikh, S. Alsagabi, and M. Almeataq, "Removal of Cd(II) from industrial wastewater using locally available Bentonite Clay," in International Conference on Water Resources and Environmental Engineering (ICWREE 2019), EDP Sciences, France, 2019.

40. P. K. Ghosh and L. Philip, "Performance Evaluation of Waste Activated Carbon on Atrazine Removal from Contaminated Water," Journal of Environmental Science and Health, Part B, vol. 40, no. 1, pp. 425–441, 2005, doi: 10.1080/03601230590923543.