Larhyss Journal, ISSN 1112-3680, n°61, March 2025, pp. 169-187

A NEW PORTABLE WATER FILTER SYSTEM FOR WASTEWATER

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Research Article – Available at http://larhyss.net/ojs/index.php/larhyss/index
Received June 7, 2024, Received in revised form January 25, 2025, Accepted January 27, 2025

ABSTRACT

Filtration enhanced the quality of water samples from various areas. The present study evaluates the impact of a portable water filter system on water quality parameters. The wastewater samples' pH readings before and after filtering, which meet environmental and discharge criteria of 6.6–8.5, vary greatly. The initial wastewater samples from domestic (pH 4.70), industrial (pH 6.90), and municipal solid waste (pH 9.28) sources have pH levels outside the permissible range. This signals acidity or alkalinity issues. Filtration raises wastewater pH to 6.93 (residential), 6.92 (industrial), and 6.71 (MSW). Residential wastewater dropped from 1.35 NTU to 1.09 NTU, within the safe drinking water range (1–5 NTU). Filtering lowered industrial wastewater turbidity from 2.67 NTU to 1.25 NTU, indicating effectiveness. After filtration, the turbidity of municipal solid waste (MSW) wastewater fell from 7.65 NTU to 4.35 NTU. After filtering, the residential wastewater content increased from 65 mg/L to 85 mg/L. This new value is within the 10-300 mg/L range but close to the maximum limit. Successful treatment reduced industrial wastewater contaminants from 240 mg/L to 184 mg/L, meeting discharge restrictions. Filtration reduced municipal solid waste (MSW) effluent from 283 mg/L to 265 mg/L, demonstrating partial pollution eradication. After filtration, residential wastewater content dropped from 295 mg/L to 265 mg/L, within the 250–500 mg/L limit. Filtration reduced industrial wastewater from 310 mg/L to 275 mg/L, proving the treatment. The filtration procedure removed pollutants, lowering MSW effluent from 440 mg/L to 395 mg/L. Thus, the implementation of a portable water filtration system has resulted in impressive improvements in wastewater quality. This includes significant improvements in pH stability, reductions in turbidity levels, and effective lowering of BOD and COD parameters. This approach not only enhances efficiency but also emphasizes our commitment to promoting sustainable water management techniques.

Keywords: Assessment; Wastewater sample; Portable water filter; pH; Turbidity; BOD; COD.

Abbreviation

BOD	Biological oxygen demand
WW	Wastewater
COD	Chemical oxygen demand
MSW	Municipal solid waste
FP	Filter paper
CG	Chhattisgarh
mg/L	Milligrams per liter
NTU	Nephelometric turbidity units
UV	Ultraviolet
AR	Analytical reagent

INTRODUCTION

The evolution of wastewater treatment reflects humanity's enduring quest to manage water quality and safeguard public health. Ancient civilizations, such as the Indus Valley around 2500 BC, engineered rudimentary drainage systems using terracotta pipes to channel wastewater into sumps, facilitating the separation of solids from liquids.

The Romans advanced these practices by constructing extensive aqueducts and sewer networks, exemplified by the Cloaca Maxima in Rome, which efficiently removed sewage from urban areas.

Following a period of stagnation during the Middle Ages, the 19th century witnessed significant advancements with the establishment of centralized sewage treatment facilities. These early plants employed physical processes, such as sedimentation, to eliminate pollutants before discharging effluent into water bodies.

The advent of the activated sludge process in the early 20th century marked a pivotal development, introducing biological treatment methods that harnessed microbial activity to degrade organic matter (Haouchine et al., 2024). In contemporary times, drinking water and wastewater treatment has become increasingly sophisticated, integrating advanced technologies to address complex contaminants, such as exchange ion processes (Aw et al., 2024) or eco-friendly adsorption processes (Bouchemal and Achour, 2007; Khelifi et al., 2018; Chauhan and Dikshit, 2023). For instance, the use of powdered activated carbon has been studied for the effective removal of harmful substances, such as phosphates, phosphorous, or heavy metals, from natural waters, highlighting ongoing innovations in treatment methodologies, especially eco-friendly technologies (Mumthaj et al., 2023; 2014; Yadav et al., 2024; Chadee et al., 2024; Khelili et al., 2024).

Integrated approaches for evaluating water quality are essential in ensuring safe and sustainable water resources, particularly in water treatment processes (Sahu et al., 2024). In addition, in water treatment, an integrated approach ensures that contaminants are effectively removed while optimizing treatment processes for drinking water, industrial use, and wastewater management. This approach combines physical, chemical, and biological assessments to provide a comprehensive understanding of water quality. Key parameters such as pH, turbidity, electric conductivity, dissolved oxygen, heavy metals, mercury, and microbial contamination are analyzed using advanced monitoring techniques and modeling tools, such as coagulation-flocculation that enhances water clarity, reduces turbidity, and improves the efficiency of downstream filtration and disinfection by minimizing the presence of pathogens and organic precursors that may form disinfection by-products (DBPs) (Masmoudi et al., 2018; Ghecham et al., 2018; Randika et al., 2022). By integrating data from field measurements, remote sensing, and optimized laboratory analyses, these methods enhance the accuracy of water quality assessments, facilitating early detection of pollutants and improving treatment efficiency (El Ghammat et al., 2019; Yoboué et al., 2019; Achour et al., 2019). Ultimately, it supports sustainable water management by providing reliable data for decision-making, regulatory compliance, and environmental protection.

The treatment of sewage sludge has become an increasingly critical environmental concern due to its high content of hazardous heavy metals and organic pollutants. If improperly managed, these contaminants can pose severe risks to soil, water, and human health, leading to long-term ecological damage. The presence of toxic substances such as lead, cadmium, mercury, carcinogenic humic substances, and persistent organic pollutants necessitates advanced treatment methods to ensure safe disposal or beneficial reuse (Bacha and Achour, 2023). Sustainable sewage sludge management involves processes like stabilization, dewatering, thermal treatment, and resource recovery to mitigate environmental risks while promoting circular economy practices. Given the growing urban population and industrial expansion, developing efficient, eco-friendly, and cost-effective sewage sludge treatment technologies is essential for environmental protection and sustainable waste management. In addition, predictive modeling of daily dried sludge production in full-scale wastewater treatment plants is crucial for optimizing sludge management and disposal strategies. By integrating machine learning algorithms with empirical mode decomposition (EMD), researchers can enhance prediction accuracy by capturing complex nonlinear patterns in sludge production data. This approach allows for improved forecasting, enabling treatment plants to efficiently plan for sludge handling, resource allocation, and environmental compliance. The combination of data-driven machine learning techniques with signal decomposition methods offers a powerful tool for optimizing wastewater treatment processes and ensuring sustainable sludge management (Zaidi et al., 2023).

This historical progression underscores a continuous enhancement of wastewater treatment processes, driven by the imperative to protect environmental and human health.

Recently, there has been a greater emphasis on finding effective and environmentally friendly methods for managing water due to growing worries about the environment and limited resources (Cosgrove and Loucks, 2015; Mishra et al., 2021; Rouissat and Smail, 2022; Aroua, 2023; Berrezel et al., 2023; Kouloughli and Telli, 2023; Kezzar and Souar, 2024). Wastewater treatment is crucial in this effort, with the goal of not just reducing pollution but also efficiently recovering and reusing water (Gaouar and Gaouar, 2016; Aroua-Berkat and Aroua, 2022). An effective method involves the use of portable water filter devices, which are designed to improve water quality by employing modern filtration technology, is an effective method (Jacobsen 2004; Verma et al., 2024; Fadhil et al., 2011). The primary objective of this study is to evaluate the efficacy of a portable water filtration system in enhancing crucial water quality indicators, including pH, turbidity, biochemical oxygen demand (BOD), and chemical oxygen demand (COD). These measures are crucial indicators of water quality and pollution levels, directly affecting aquatic ecosystems and human well-being (Poonam et al., 2013; Tyagi et al., 2013; Ounoki and Achour, 2014; Baba Hamed, 2021). The filtration system's portability enables it to be easily used in a wide range of situations, including industrial wastewater treatment and decentralized community water purification projects. This study aims to evaluate the system's effectiveness and potential uses in both urban and rural environments by analyzing its performance in various water sources and situations. Understanding the impact of these systems on water quality metrics is critical to optimize their implementation and provide guidance for future water management strategies (El-Harbawi, 2010; Naitali and Ghoualem, 2015; Bouklia-Hassane and Yebdri, 2015; Behmel et al., 2016). This project enhances sustainable water treatment techniques by investigating cutting-edge technologies that facilitate the purification of water resources, ensuring their cleanliness and safety for communities across the globe.

The quality of water is a significant global issue that affects both human well-being and environmental sustainability (Kahoul and Touhami, 2014; Aboubakar et al., 2017). As populations increase and industrial activity rises, the task of guaranteeing access to uncontaminated and secure drinking water becomes progressively more difficult (Remini, 2010; Li and Wu, 2019; Somadjago et al., 2019; Gomis and Thior, 2020). Portable water filter systems provide a viable alternative by providing convenient filtration capabilities that can improve water quality in a variety of environments, including outdoor expeditions, emergency scenarios, and routine domestic usage (Kyriienko et al., 2029; Verma et al., 2024; Yusuf and Murtala, 2020). This assessment aims to evaluate various portable water filtration systems using important water quality indicators (Calvert and Mazumder, 2016; Razman et al., 2023; Damo and Icka, 2013; Yusuf et al., 2019). Parameters such as pH, turbidity, and bacterial concentration are essential indications of water safety and cleanliness. By evaluating these parameters in various filtration systems, we can ascertain their efficacy in eliminating impurities and enhancing the overall quality of water. The study will investigate several portable filter technologies, such as activated carbon filters, ceramic filters, and membrane filters (Baker et al., 2000; Bandosz, 2006; Ihsan and Derosya, 2024). Every filter type possesses distinct capabilities for effectively targeting certain impurities and ensuring the clarity of water. Assessing their effectiveness in practical situations is crucial for suggesting appropriate filtration options for different user requirements and environmental circumstances. Therefore, this study aims to provide valuable insights to consumers, policymakers, and environmentalists by analyzing the strengths and shortcomings of various models. The goal is to help with the selection of suitable technologies that can improve water quality and support sustainable water management practices.

BACKGROUND OF THE STUDY

The evolution of portable water filters throughout history spans thousands of years, showcasing humanity's unwavering pursuit of purified and secure drinking water. Ancient civilizations developed primitive techniques for purifying water using natural substances such as sand, gravel, and charcoal, as evidenced by ancient Sanskrit books from India that are many millennia old. In the 17th century, scientists like Sir Francis Bacon conducted innovative experiments to investigate filtration methods using porous substances such as sand and charcoal to eliminate contaminants. These initial endeavours established the fundamental foundations for contemporary filtration technology. During the 19th century, there were notable improvements in portable water filtration. In 1827, Robert Thom obtained a patent for a ceramic water filter that utilized a porous earthenware container. By effectively capturing particles and bacteria, this discovery enhanced the quality of water and established a model for ceramic filtering techniques still in use today. The advent of activated carbon in the early 20th century brought about a significant transformation in the field of water filtration (Khelili et al., 2010; Ouakouak and Youcef, 2016). The capacity of activated carbon to absorb pollutants has made it an essential element in portable water filtration systems, successfully eliminating organic compounds, chlorine, and undesirable flavours and smells from water. Portable water filters became strategically significant during World War II as they supplied safe drinking water to military forces stationed in remote areas and combat zones. This period stimulated progress in the development of small, resilient, and effective filtration devices that are appropriate for use in outdoor environments. During the later half of the 20th century, there were additional advancements made in portable water filtration technology. Membrane technology advancements, such as microfiltration and ultrafiltration, have improved filtration effectiveness by effectively eliminating minute microorganisms and particles. In addition, ultraviolet (UV) light sterilization has evolved as a non-chemical technique for disinfecting water, which complements traditional filtration technologies (Achour and Chabbi, 2014).

OBJECTIVE OF THE PRESENT STUDY

The objective of designing portable water filters is to methodically assess and enhance their efficacy, user-friendliness, and influence in delivering safe drinking water. The main objectives typically include:

1. To assess the filtering efficiency and efficacy of a portable water filter design across various water sources.
2. Examine the treated water's quality parameters using the developed filter.

MATERIAL AND METHODS

The materials and methods used in a household wastewater filter that utilizes activated charcoal are critical for providing a comprehensive description of the components and procedures used in its production and operation (Bhatnagar et al., 2013; Musa et al., 2020). Activated charcoal serves as the primary filtering agent due to its porous structure and high adsorption capacity. The filter typically consists of activated charcoal granules contained within a container, inlet, and output pipes for regulating water flow, as well as a collection tank for collecting filtered water. We construct the filter by evenly dispersing activated charcoal granules within the housing, ensuring efficient interaction with wastewater as it flows through. The inflow pipe directs the wastewater into the filter, where pollutants adhere to the charcoal's surface through adsorption. The outlet pipe then discharges the cleaned water, making it ready for reuse or processing.

STUDY AREA DESCRIPTION

The coordinates of Bhilai are 21.22°N, 81.43°E (Fig. 1). The average elevation is 293 m (961 ft). The city is located 22 km west of Raipur, the capital city, along the Howrah-Mumbai railway route and National Highway 6. Bhilai is well-known for its integrated steel plant, which is one of India's largest steel mills. The investigation focused on the tap drinking water supply at the Rungta campus of Engineering and Technology, located in Kohka Bhilai. We also collected samples from the household drinking water supply in Kohka near Arya Nagar and the railway station in Durg.

Figure 1: Study area map (https://www.mapsofindia.com/).

PRIMARY DATA COLLECTION

The majority of the research's data was collected during fieldwork. The primary purpose of the fitter medium is to remove the water's temporary hardness. The second part entails the water's permanent softening. The design process begins with careful material selection, followed by filter design, filter testing, and water quality assessment. It concludes with the acquisition of the desired outcome. The design of the portable water filter consists of three components. The third part comprises an alternate layer specifically designed to extract organic hardness from the water sample. We measured pH at the sample site immediately after sample collection. We used the Elico CM 180 Conductivity Bridge to measure the electrical conductivity values. All the chemicals utilized were of analytical reagent (AR) grade. From September 21–24, 2013, we collected five groundwater samples from various locations in Bhilai City, each from a distinct groundwater source. We collected samples from residential (R), industrial (I), and adjacent municipal solid waste (MSW) dumpsite locations.

METHODOLOGY

The process of developing a portable water filter entails various essential stages. Initially, establish the filtering objectives according to the specified water quality criteria. Choose an appropriate filtration medium, such as activated carbon, ceramic, or filter paper, based on the specific pollutants that are present. Develop the filter housing using materials such as plastic or metal, taking into account factors such as durability and weight. Enhance the filter structure to maximize water flow efficiency and facilitate user-friendly operation in portable environments. Perform laboratory and field experiments to evaluate the effectiveness of filtration, the rate at which fluids pass through, and the ability to withstand different circumstances. Finally, improve the design based on test results to achieve the highest efficiency in delivering safe potable water. Here the methodology adopted for the present study is illustrated in Fig. 2.

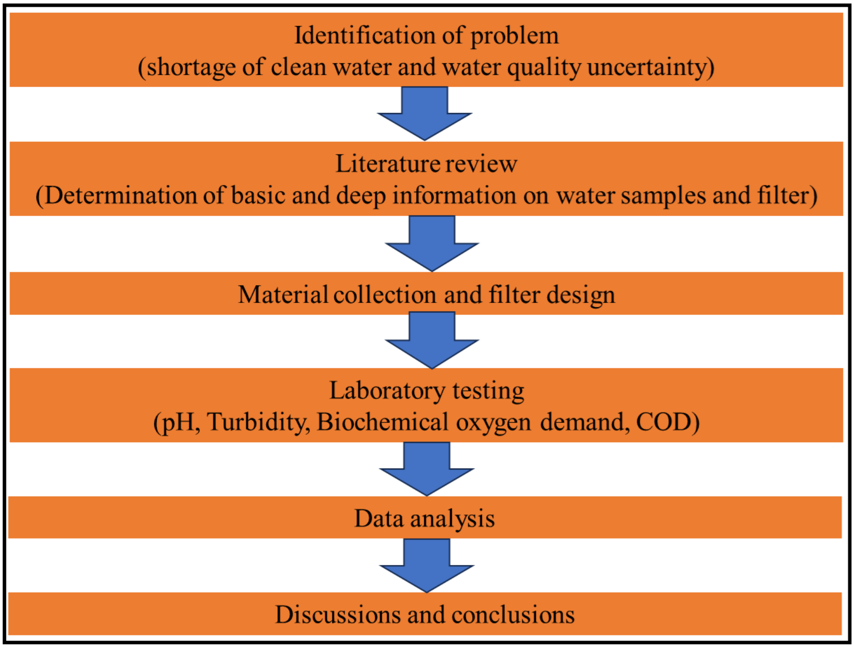

Figure 2: Methodology

Significance of the system

The design of a portable water filtration system is critical for ensuring access to potable water in a variety of settings and during times of crisis. It tackles the worldwide problem of waterborne illnesses by offering a portable and dependable method of water treatment. These systems enable people and groups to autonomously obtain clean water, even in situations where centralized infrastructure is unavailable, such as after natural catastrophes or in distant places with limited access to reliable water sources. Furthermore, they advocate for sustainability by reducing their reliance on disposable plastic bottles and minimizing their ecological footprint. In general, portable water filters play a significant role in promoting public health, environmental responsibility, and the ability to withstand emergencies by ensuring that safe drinking water is available to everyone.

Filter media

A plastic bottle with a capacity of two liters contains multiple layers (Fig. 3). Filter layering consists of three components. The initial part of the filtering media's primary function is to remove the sample water's thermal hardness. Using lime, the lime layer has a thickness of around 2–2.5 cm. We measure this after we have retained the lime filter paper layer. Ultimately, we form the second part of the filter medium by utilizing bentonite clay, which effectively and permanently removes the hardness from the sample water. We consistently maintain the layer's thickness at two centimeters after applying a layer of bentonite clay-composed filter paper. The primary function of the third segment of the filter is to remove organic pollutants from the water sample. Activated carbon forms the first of its four layers. The initial layer consists of approximately 4 cm of activated carbon. We position the filter paper adjacent to the layer. The second layer is composed of coconut fibre with a 2 cm thickness. The third layer consists of bio-balls. A total of 25 bio-balls are present, with filter paper positioned 2 cm downstream from the bio-balls. Mineral sand makes up the fourth layer, where we store the filter paper.

Figure 3: Filter media of portable water filter system with multiple layers

RESULTS AND DISCUSSION

This section presents the data and analysis of the measurements of water samples before and after passing through a water filter produced using coconut husk fibre, charcoal (active carbon), zeolite, and membrane. We conducted the experiments to assess the efficacy of these portable filter media. The table and graphs display the values of pH, biological oxygen demand (BOD), and COD. The collection and analysis of this data are crucial for the construction of the model. We collected five water samples (Industrial, Residential, and MSW) both before and after filtration.

pH

Table 1 and Fig. 4 show the pH readings of the wastewater samples, both before and after filtering, exhibit substantial variations that align with the target pH range of 6.6–8.5, as stipulated by environmental and discharge standards. The initial wastewater samples obtained from household (pH 4.70), industrial (pH 6.90), and municipal solid waste (pH 9.28) sources display pH levels that go outside the acceptable range. This suggests the presence of possible acidity or alkalinity problems. Following the filtration process, the pH levels of the treated wastewater samples show improvement, measuring at 6.93 (residential), 6.92 (industrial), and 6.71 (MSW). The results show that filtration methods can effectively achieve pH correction, bringing the wastewater's pH within the permitted range to ensure environmental safety and regulatory compliance.

Table 1: Data of pH value before and after filtered

S. No.	Wastewater samples	Before filtered	Unit	Range	Outcome (After filtered)
1	Residential	4.7			6.93
2	Industrial	6.9	-	6.6-8.5	6.92
3	MSW	9.28			6.71

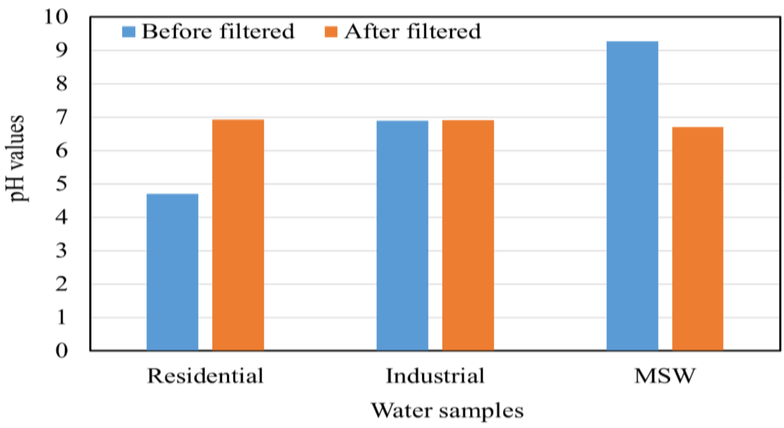

Figure 4: Graph of pH value against wastewater samples.

Turbidity

The findings demonstrate significant decreases in turbidity levels in several wastewater samples following filtration (Table 2 and Fig. 5). Residential wastewater decreased from 1.35 NTU to 1.09 NTU, which falls within the acceptable range for safe drinking water (1–5 NTU). The industrial wastewater showed a decrease in turbidity from 2.67 NTU to 1.25 NTU after filtering, indicating successful treatment. Nevertheless, the wastewater from municipal solid waste (MSW), which initially had a turbidity of 7.65 NTU, decreased to 4.35 NTU after undergoing filtration. This indicates that there are still difficulties in immediately meeting the standards for drinking water. These findings emphasize the effectiveness of filtration methods in enhancing water quality. They also emphasize the necessity of customized strategies to tackle elevated turbidity levels in MSW wastewater to ensure its safety for consumption.

Table 2: Data of turbidity value before and after filtered.

S. No.	Wastewater samples	Before filtered	Unit	Range	Outcome (After filtered)
1	Residential	1.35	NTU	1-5 NTU	1.09
2	Industrial	2.67			1.25
3	MSW	7.65			4.35

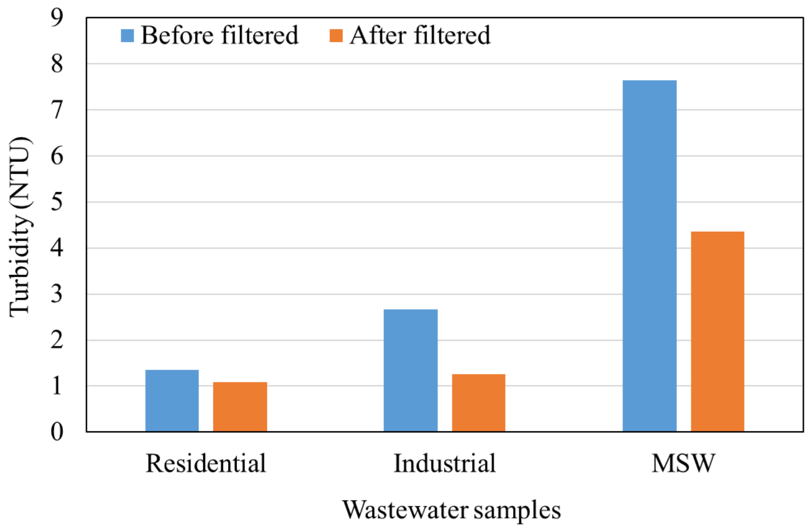

Figure 5: Graph of turbidity value against wastewater samples.

BOD

The results (Table 3 and Fig. 6) demonstrate substantial alterations in pollutant concentrations after filtration in several types of wastewaters. The concentration of residential wastewater, initially at 65 mg/L, experienced a modest increase to 85 mg/L after undergoing filtration. This new concentration falls within the permissible range of 10-300 mg/L, but it is closer to the top limit. The concentration of pollutants in the industrial wastewater decreased from 240 mg/L to 184 mg/L, demonstrating successful treatment that meets the required limits for discharge. Nevertheless, the concentration of municipal solid waste (MSW) effluent fell from 283 mg/L to 265 mg/L following filtration, indicating a partial elimination of pollutants.

Table 3: Data of BOD value before and after filtered.

S. No.	Wastewater samples	Before filtered	Unit	Range	Outcome (After filtered)
1	Residential	65	mg/L	10-300 mg/L	85
2	Industrial	240			184
3	MSW	283			265

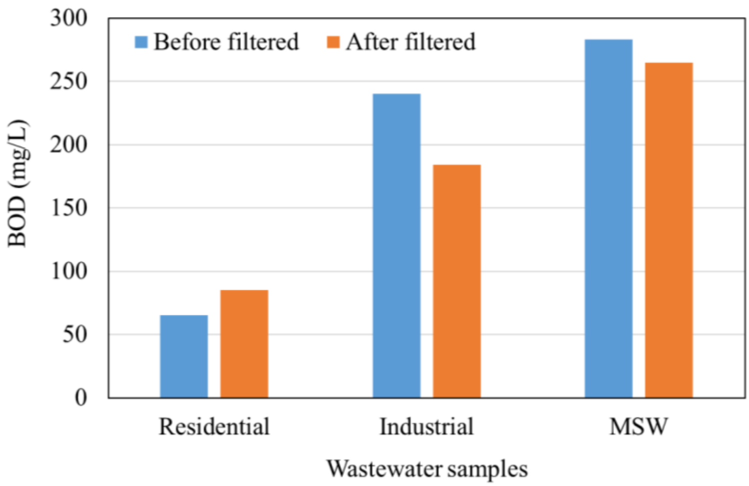

Figure 6: Graph of BOD values against wastewater samples.

COD

The results indicate (Table 4 and Fig. 7) a successful decrease in contaminant levels in several wastewater samples after filtration. The concentration of residential wastewater was initially 295 mg/L but fell to 265 mg/L after filtration, which is within the permitted range of 250–500 mg/L. The industrial wastewater showed improvement, decreasing from 310 mg/L to 275 mg/L after filtration, demonstrating successful treatment. The filtration process successfully eliminated contaminants, reducing the concentration of municipal solid waste (MSW) effluent from 440 mg/L to 395 mg/L. These findings highlight the effectiveness of filtration technologies in improving water quality by decreasing pollutant concentrations in various types of wastewaters. Sustained surveillance and refinement of filtration techniques are critical for upholding environmental regulations and guaranteeing the safe reuse or release of water.

Table 4: Data of COD value before and after filtered

S. No.	Wastewater samples	Before filtered	Unit	Range	Outcome (After filtered)
1	Residential	295	mg/L	250-500 mg/L	265
2	Industrial	310			275
3	MSW	440			395

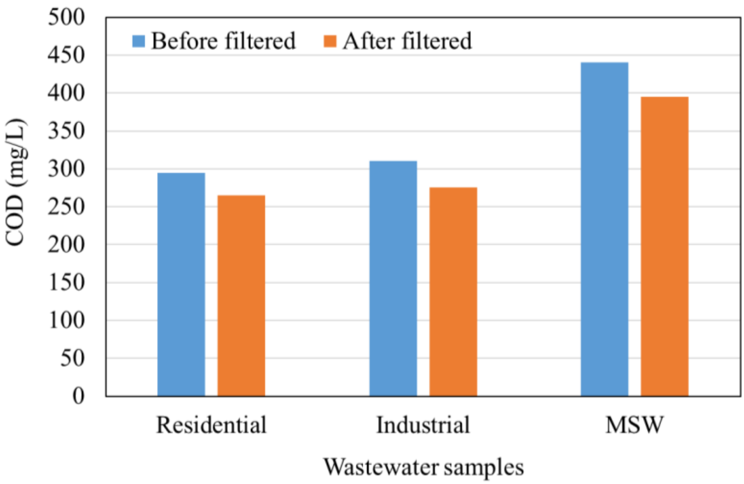

Figure 7: Graph of COD values against wastewater samples.

CONCLUSION

The filters significantly improved the water quality of samples from three different locations. Key parameters such as pH, turbidity, biological oxygen demand (BOD), and chemical oxygen demand (COD) showed noticeable enhancements. The study highlighted the diverse chemical composition of wastewater. We observed some discrepancies in rainwater samples pre- and post-filtration, indicating a need for filter material refinement, even though the produced filters effectively enhanced wastewater quality. As a result, developing filters from natural ingredients appears to be a promising and effective approach for treating and improving rainwater quality for daily use.

Limitations of the present study

The study design for a portable water filter may face many difficulties that could affect its dependability and suitability. Firstly, the laboratory-based nature of many studies may not accurately replicate real-world scenarios where water quality variations and environmental factors can influence filter effectiveness in diverse ways. Additionally, the limited time of experimental testing may fail to accurately assess the long-term efficiency and resilience of the filter when used continuously.

Future scope of the study

The future scope of potable water filter studies holds promise for several advancements and applications. Integrating sensors and IoT capabilities can provide real-time monitoring of water quality and filter operation, improving efficiency and user convenience. Additionally, investigating sustainable materials and renewable energy sources for filter operation has the potential to decrease environmental harm and operational expenses, hence enhancing the availability of filtration devices in rural or underserved areas.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

The authors wish to express their gratitude towards the Rungta College of Engineering and Technology, Bhilai for their kind support and for providing the opportunity to conduct the present study.

REFERENCES

ABOUBAKAR, ABDOUL W., BOUBA L. (2017). Characterization of surface water around an agro industrial company in Maroua-Cameroon, Larhyss Journal, No 29, pp. 209-225. (In French)

ACHOUR S., CHABBI F. (2014). Disinfection of drinking water-constraints and optimization perspectives in Algeria, Larhyss Journal, No 19, pp. 193-212.

ACHOUR S., MODJAD H., HELLAL H., KELILI H. (2019). Optimization tests of clarification and disinfection processes of water dam of Khenchela area (eastern Algeria), Larhyss Journal, No 37, pp. 151-174. (In French)

AROUA N. (2023). Setting out urban water issues examples from Algeria and worldwide, Larhyss Journal, No 56, pp. 309-327.

AROUA-BERKAT S., AROUA N. (2022). Opportunities and challenges for wastewater reuse in Algeria, Larhyss Journal, No 51, pp. 7-17.

AW S., SAVADOGO I., OGA Y.M.S., COULIBALY M.R. (2024). Contribution of ion exchange processes in the elimination of nitrates contained in the waters of the Abidjan aquifer (south Cote d'Ivoire), Larhyss Journal, No 60, pp. 7-25.

BABA HAMED S. (2021). Impact of water pollution on public health and the environment in Oran, Larhyss Journal, No 45, pp. 203-222.

BACHA N., ACHOUR S. (2023). Polymeric humic material removal by coagulation-flocculation stoichiometric dosage aluminum sulphate/humic acid in saline aqueous media, Larhyss Journal, No 53, pp. 199-217.

BAKER F.S., MILLER C.E., REPIK A.J., TOLLES E.D. (2000). Activated carbon, Kirk-Othmer Encyclopedia of Chemical Technology, Vol. 2. https://doi.org/10.1021/j150469a016

BANDOSZ T.J. (2006). Activated carbon surfaces in environmental remediation, Elsevier, 1st Edition, Vol. 7, 588p., Hardback ISBN 9780123705365, eBook ISBN 9780080455952

BEHMEL S., DAMOUR M., LUDWIG R., RODRIGUEZ M.J. (2016). Water quality monitoring strategies - A review and future perspectives, Science of the Total Environment, Vol. 571, pp. 1312-1329. https://doi.org/10.1016/j.scitotenv.2016.06.235

BERREZEL Y.A., ABDELBAKI C., ROUISSAT B., BOUMAAZA T., KHALDOON A.M. (2023). Decision support system for the management of water distribution networks, a case study of Tourville, Algeria, Larhyss Journal, No 54, pp. 7-24.

BHATNAGAR A., HOGLAND W., MARQUES M., SILLANPÄÄ M. (2013). An overview of the modification methods of activated carbon for its water treatment applications, Chemical Engineering Journal, Vol. 219, pp.499-511.

BOUCHEMAL F., ACHOUR S. (2007). Tyrosine adsorption tests on grained and powdered activated carbon, Larhyss Journal, No 6, pp. 81-89. (In French)

BOUKLIA-HASSANE R., YEBDRI D. (2015). Analysis and simulation of alternative scenarios for development of water resources in the Wilaya of Oran in the medium-long term, Larhyss Journal, No 22, pp. 15-24. (In French)

CALVERT J.G.N., MAZUMDER Q. (2016). Design and Development of a Portable Water Filtration System, Proceedings of the 2016 American Society for Engineering Education (ASEE) North Central Section Conference, pp. 1-8. https://asee-ncs.org/wp-content/uploads/2021/12/proceedings/2016/student_regular_papers/2016_ASEE_NCS_paper_39.pdf

CHADEE A.A., RATHORE K., CHOUDHARY L.A., VERMA S., MEHTA D. (2024). The korba coal mining zone in India assessment of risk health and pollutant sources, Larhyss Journal, No 60, pp. 113-131.

CHAUHAN S.S., DIKSHIT P.K.S. (2023). Cadmium metal scavenging capability of spent tea grains - an agricultural biomass waste as a low-cost adsorbent, Larhyss Journal, No 55, pp. 161-189.

COSGROVE W.J., LOUCKS D.P. (2015). Water management: Current and future challenges and research directions, Water Resources Research, Vol. 51, Issue 6, pp. 4823-4839. https://doi.org/10.1002/2014WR016869

DAMO R., ICKA P. (2013). Evaluation of Water Quality Index for Drinking Water, Polish Journal of Environmental Studies, Vol. 22, Issue 4, pp. 1045-1051

EL GHAMMAT A., TEMSAMANI RIFFI K., HASSANI ZERROUK M. (2019). A study of the performance of a sequential bioreactor plant for the treatment of dairy effluents, Larhyss Journal, No 37, pp. 7-21. (In French)

EL-HARBAWI M. (2010). Design of a portable dual purposes water filter system, Journal of Engineering Science and Technology, Vol. 5, Issue 2, pp.165-175.

FADHIL R., ENDAN J., ARZIMAN S.N.B.S., TAIP F.S., JA'AFAR M.S.B.H. (2011). Effectiveness of floating microbead bio-filter for ornamental fish in a recirculating aquaculture system, Fisheries and Aquaculture Journal, Vol. 1, pp.1-8.

GAOUAR Y.M., GAOUAR B.N (2016). Best available technology assessment of three existing processes in waste water treatment field, Larhyss Journal, No 27, pp. 105-123. (In French)

GHECHAM F.Z., GUERGAZI S., ACHOUR S. (2018). Removal of caffeine by coagulation-flocculation with aluminum sulfate and effect of metal salts, Larhyss Journal, No 34, pp. 115-126. (In French)

GOMIS J.S., THIOR M. (2020). Access to drinking water and sanitation in the informal neighbourhoods of the municipality of Ziguinchor (Senegal): the example of Nema 2 and Coboda, Larhyss Journal, No 41, pp. 27-46. (In French)

HASSEN J.H., ABDULKADIR H.K. (2022). Recent developments in the use of activated charcoal in medicine, Journal of Medical Science, Vol. 91, Issue 2, https://doi.org/10.20883/medical.e647

HAOUCHINE A., NEDJAI R., MOTELICA-HEINO M., NEMER Z. (2024). Characterization of the spatio-temporal dynamic of fluorescent dissolved organic matter in the ponds of Brenne (France) using EEM-PARAFAC model, Larhyss Journal, No 60, pp. 273-291.

IHSAN T., DEROSYA V. (2024). Drinking water problems in rural areas: review of point-of-use methods to improve water quality and public health, Larhyss Journal, No 58, pp. 55-71.

JACOBSEN E.K. (2004). Water filtration, Journal of Chemical Education, Vol. 81, Issue 2, Paper ID 224A.

KAHOUL M., TOUHAMI M. (2014). Evaluation of the physico-chemical quality of consumption water in the city of Annaba (Algeria), Larhyss Journal, No 19, pp. 129-138. (In French)

KEZZAR M.A., SOUAR A. (2024). The water management system in the village of Menades in Algeria between past and present, Larhyss Journal, No 57, pp. 55-79.

KHELIFI O., MEHREZ I., YOUNSI M., NACEF M., AFFOUNE A.M. (2018). Methyl orange adsorption on biosorbent derived from mango seed kernels, Larhyss Journal, No 36, pp. 145-156. (In French)

KHELILI H., ACHOUR S., REZEG A. (2010). Effectiveness of aluminum sulfate and activated carbon against aromatic organic pollutants, Larhyss Journal, No 9, pp. 99-110. (In French)

KHELILI H., ACHOUR S., KONAN K.G., GUELLAL M. (2024). Kinetic and isotherm study of methylene blue adsorption on orange peel activated carbon, Larhyss Journal, No 58, pp. 89-103.

KOULOUGHLI C.E., TELLI A. (2023). Modern water supply management techniques and methods: a review, Larhyss Journal, No 55, pp. 7-23.

KYRIIENKO P.G., KYRIIENKO V.V., CHUMACHENKO A.V. (2019). Portable device for water purification, Journal of the Environmental Safety and Natural Resources, Kyiv National University of Construction and Architecture, Institute of Telecommunications, ISSN: 2411-4049, Vol. 29, No 1, pp. 65-70. https://es-journal.in.ua

LI P., WU J. (2019). Drinking water quality and public health. Exposure and Health, Vol. 11, Issue 2, pp.73-79. https://doi.org/10.1007/s12403-019-00299-8

MASMOUDI T., GUERGAZI S., ACHOUR S. (2018). Mercury removal by activated carbon, Larhyss Journal, No 34, pp. 21-38. (In French)

MISHRA B.K., KUMAR P., SARASWAT C., CHAKRABORTY S., GAUTAM, A. (2021). Water security in a changing environment: Concept, challenges and solutions, Water, Vol. 13, Issue 4, Paper ID 490. https://doi.org/10.3390/w13040490

MUSA A., SANI SALEH K.M., LABARAN Y.H., YAU J.Z., MATO H. (2020). Evaluation of potential use of charcoal as a filter material in water treatment, International Research Journal of Engineering and Technology, Vol. 7, Issue 5, pp. 1930-1939.

MUMTHAJ A.M.M., DISSANAYAKA D.M.S.H., MOWJOOD M.I.M. (2023). Enhancement of phosphorous removal from wastewater using Murunkan clay mixed media, Larhyss Journal, No 53, pp. 145-163.

NAITALI F., GHOUALEM H. (2015). Use of artificial neural networks as a management and decision-making tool, application to the quantification of the effect of discharges of a mixture of medications on activated sludge from treatment plants, Larhyss Journal, No 22, pp. 71-79. (In French)

OUNOKI S., ACHOUR S. (2014). Evaluation of the physicochemical and bacteriological quality of raw and purified wastewater of the city of Ouargla, Possibility of their valorization in irrigation, Larhyss Journal, No 20, pp. 247-258. (In French)

OUAKOUAK A.K., YOUCEF L. (2016). Adsorption of Cu^{2+} ions on powder activated carbon and a sodique bentonite, Larhyss Journal, No 27, pp. 39-61. (In French)

POONAM T., TANUSHREE B., SUKALYAN C. (2013). Water quality indices-important tools for water quality assessment: a review, International Journal of Advances in chemistry, Vol. 1, Issue 1, pp.15-28.

RANDIKA M.A., AMARASOORIYA A.A.G.D., WERAGODA S.K. (2022). Development of an Arduino-based low-cost turbidity and electric conductivity meter for wastewater characterization, Larhyss Journal, No 51, pp. 115-127.

RAZMAN N.A., WAN ISMAIL W.Z., ABD RAZAK M.H., ISMAIL I., JAMALUDIN J. (2023). Design and analysis of water quality monitoring and filtration system for different types of water in Malaysia, International Journal of Environmental Science and Technology, Vol. 20, Issue 4, pp. 3789-3800. https://doi.org/10.1007/s13762-022-04192-x

REMINI B. (2010). The water problem in northern Algeria, Larhyss Journal, No 8, pp. 27-46. (In French)

ROUISSAT B., SMAIL N. (2022). Contribution of water resource systems analysis for the dynamics of territorial rebalancing, case of Tafna system, Algeria, Larhyss Journal, No 50, pp. 69-94.

SAHU S., SUPE J., RATHORE K., VERMA S., MEHTA D. (2024). An integrated approach for evaluating water quality, Larhyss Journal, No 60, pp. 213-230.

SOMADJAGO M., CISSOKHO D., SUKA D.K. (2019). Difficulty in accessing Lomé's peripheral area to public distribution network water and alternative solutions, Larhyss Journal, No 38, pp. 35-48. (In French)

TYAGI S., SHARMA B., SINGH P., DOBHAL R. (2013). Water quality assessment in terms of water quality index, American Journal of water resources, Vol. 1, Issue 3, pp. 34-38.

VERMA D., SUPE J., VERMA S., SINGH R.R. (2024). Removal of Fluoride from Drinking Water by Utilizing Modified Bagasse Sugarcane as Low-Cost Adsorbents for Bilaspur City, Chhattisgarh, Journal of Environmental Informatics Letter, Vol. 11, Issue 2. http://dx.doi.org/10.3808/jeil.202400126

YADAV S., KHAN F., RATHORE K., VERMA S., MEHTA D. (2024). Household waste water treatment with the aid of activated charcoal, Larhyss Journal, No 60, pp. 133-150.

YOBOUÉ K.P., GOSSO O., DAGO H.J., KOUAMÉLAN E.P. (2019). Study of the operational performance of dissolvers of a drinking water production unit: case of the Sodeci northern factory (Abidjan), Larhyss Journal, No 37, pp. 115-127. (In French)

YUSUF K.O., ADIO-YUSUF S.I., OBALOWU R.O. (2019). Development of a simplified slow sand filter for water purification, Journal of Applied Sciences and Environmental Management, Vol. 23, Issue 3, pp. 389-393.

YUSUF K.O., MURTALA M.O. (2020). Development and performance evaluation of a portable household ceramic water filter with activated carbon and magnetic treatment unit, International Journal of Environmental Science and Technology, Vol. 17, pp. 4009-4018.

ZAIDI K., DJEDDOU M., SEKIOU F., HAMEED I.A., SHAWAQFAH M. (2023). Predictive modelling of daily dried sludge production in full-scale wastewater treatment plant using different machine learning combined with empirical mode decomposition, Larhyss Journal, No 56, pp. 77-106.