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Ceramic Vessel Filter for Water Treatment in Nigeria's Rural, Underdeveloped Communities

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Abstract: Access to clean and safe drinking water remains a significant challenge in Nigeria's rural, underdeveloped communities, contributing to waterborne diseases and poor health outcomes. In order to address this issue, this study proposes the use of ceramic vessel filters (CVFs) as a cost-effective and sustainable solution for household water treatment. This research explored the effectiveness of CVFs focused on the specific needs and constraints of rural communities in Nigeria. The CVFs use locally available materials, such as clay and sawdust, as well as traditional ceramic craftsmanship, making them culturally acceptable and easily replicable. The study evaluated the filtration efficiency of CVFs in removing common water contaminants such as bacteria and protozoa by identifying testing and field trials conducted in similar rural settings. Additionally, the study assesses factors that influence adoption and long-term sustainability, such as user acceptance, maintenance requirements, and community engagement. The findings highlighted the efficacy of CVFs in improving water quality and reducing the incidence of waterborne diseases in rural Nigerian communities. Furthermore, the study underscored the importance of integrating community participation and capacity-building initiatives to ensure the successful implementation and widespread adoption of CVFs as a viable water treatment solution. Overall, this research contributes to addressing the pressing need for sustainable and locally appropriate water treatment technologies in Nigeria's rural, underdeveloped communities, with implications for similar contexts globally.

Keywords: Ceramic Vessel Filter, Water Treatment, Nigeria, Underdeveloped Communities
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INTRODUCTION

One of the major problems facing nations in developing economies is the unavailability and inaccessibility of clean and safe drinking water. For example, according to Aaron Salzberg, a one-time Special Coordinator for water resources at the State Department Bureau of Oceans, Environment, and Science, United States of America, the proportion of people who lack access to safe drinking water and sanitation is particularly high in Africa, particularly among poor and rural populations. He also states that the lack of safe water, sanitation, and hygiene is responsible for the “leading causes” of death in children under five years old in Africa (*Nigerian Tribune,* March 1, 2017*)*. Access to clean and safe drinking water is a fundamental human right crucial for maintaining health and preventing waterborne diseases, yet millions of people, especially in rural areas of Nigeria, lack this basic necessity. In many rural communities in Nigeria, access to safe drinking water remains a significant challenge due to the contamination of water sources with pathogens and pollutants. The traditional methods of water treatment, such as boiling and chlorination, are often inaccessible or unsustainable in these regions. In response to this crisis, innovative solutions are imperative. One such solution gaining traction is the Ceramic Vessel Filter (CVF) for water treatment. Taking cognizance of the facts presented in the foregoing, this study investigates the significance of CVFs in addressing waterborne diseases in Nigeria's rural communities, as this would be very useful in various circumstances, environments, and settings such as health care centres and homes.

The Need for Clean Water in Nigeria's Rural Communities

Nigeria, despite being Africa's largest economy, faces significant challenges in providing clean water to its citizens, particularly those living in rural areas. According to UNICEF, over 57 million Nigerians lack access to safe

drinking water, with rural communities disproportionately affected (UNICEF, 2022). Contaminated water sources, such as rivers, streams, and shallow wells, are often the only options available, leading to high rates of waterborne diseases like cholera, typhoid fever, and diarrheal illnesses. The contamination of water sources by bacteria, viruses, protozoa, and chemical pollutants poses a significant threat to public health in rural communities. Another cause for concern is that the scarcity of clean water impedes economic progress in rural Nigeria. Without access to safe water for drinking, sanitation, and agriculture, communities struggle to meet their basic needs and develop sustainable livelihoods.

According to the United Nations Development Programme (UNDP, 2019), water-related diseases and the time required for water collection divert resources away from education, business opportunities, and other income-generating activities. Thus, addressing the water crisis is crucial for fostering economic growth and poverty alleviation. In addition to its human toll, the lack of clean water in Nigeria's rural areas also has adverse environmental consequences. Unregulated water extraction, contamination from agricultural runoff, and inadequate sanitation infrastructure contribute to water pollution and ecosystem degradation. The degradation of water sources not only threatens biodiversity, but it also compromises the long-term sustainability of water resources, exacerbating the challenges faced by future generations.

Nevertheless, the Nigerian government has recognised the importance of addressing this water crisis and has implemented various initiatives to improve access to clean water in rural communities. For instance, the National Water Resources Policy aims to enhance water governance, infrastructure development, and water quality management (Federal Ministry of Water Resources, 2016). However, challenges such as inadequate and misappropriated funds, weak institutional capacity, and inefficient implementation. In this same vein, communal involvement is essential for addressing the water crisis sustainably. Initiatives that empower local communities to manage their water resources can lead to more effective and equitable solutions. Organisations like WaterAid Nigeria and UNICEF work with communities to build infrastructure, promote hygiene education, and strengthen local governance structures (WaterAid Nigeria, n.d.; UNICEF Nigeria, n.d.). By involving communities in decision-making processes and capacity-building activities, these initiatives foster ownership and ensure the long-term sustainability of water projects.

The Ceramic Vessel Filter

Firstly, a water filter is any device that removes undesirable substances from drinking water, such as bacteria or harmful chemicals. The history of water filters inextricably intertwines with the history of water itself. As pointed out, “as human industry has grown and water has become more contaminated, water filters have emerged over the centuries in response to the rising realisation of the need for pure, clean water to drink and the realisation that such water does not occur naturally” (“History of Water Filters,” 2016). The first documented experiment in water filtration, after the blight of the Dark Ages, came from Sir Francis Bacon in 1627, who, hearing rumours that the salt water of the sea could be purified and cleaned for drinking water purposes, began experimenting in the desalination of seawater using a sand filter method (Baker and Taras, 1981). It was a similar quest to achieve simpler and more accessible ways of water filtration that propelled the invention of the ceramic vessel filter. The ceramic vessel filter is a pot-shaped filter that is achieved by compounding clay and sawdust to specific ratios and then firing at about 900 degrees Celsius to attain a solid porous state (Plate 1). We then place the fired ceramic vessel filter in a receptacle with a tap mouth (Plate 2) to collect and dispense filtered water.

Plate 1: Ceramic Vessel Filter (CVF)
Source: https://www.cdc.gov/safewater/ceramic-filtration.html

Plate 2: Installed Ceramic Vessel Filter
Source:https://kopernik.info/technology/tcm-ceramic-water-filter-water-filter

The Ceramic Vessel Filter (CVF) is emerging as a cost-effective and sustainable solution to water purification in resource-constrained settings, like the households of a few Nigerian rural communities. CVFs are simple, clay-based water filtration devices designed to remove bacteria, protozoa, and other contaminants from water sources. These filters work by trapping impurities as water passes through small pores in the ceramic pot or vessel walls. Local manufacturing processes can adapt to the relatively simple production of CVFs, making them suitable for resource-limited settings. Research studies have demonstrated the efficacy of CVFs in improving water quality and reducing the incidence of waterborne diseases in rural communities. For instance, a randomised controlled trial in Cambodia found that households using CVFs experienced a 46% reduction in diarrhoea prevalence compared to control groups (Brown et al., 2008). In Ghana, a trial revealed a 30% decrease in diarrheal disease among households using CVFs compared to those without filtration (Clasen et al., 2014). Similarly, Murcott et al. (2018) studied how well CVFs worked in Ghana and found that they significantly reduced the amount of faecal coli forms and E. coli counts in water that had CVFs added to it. Also, studies in other Sub-Saharan African countries have yielded consistent results, highlighting the effectiveness of CVFs in improving public health outcomes.

Challenges and opportunities

Despite their effectiveness, widespread adoption of CVFs in Nigeria's rural communities faces several challenges. Adesokan (2023) points out that many rural communities in Nigeria are uninformed about the significance of clean water and the availability of technologies like CVFs. Furthermore, there is often insufficient education regarding the correct usage and maintenance of these filters, resulting in their underutilization or incorrect handling. Financial limitations also pose a significant obstacle to the widespread adoption of CVFs in rural Nigerian communities. Numerous communities struggle to cover the initial costs of purchasing filters, or lack access to microfinance options for financing such acquisitions. Moreover, rural areas frequently lack the essential infrastructure for efficiently distributing CVFs due to inadequate road networks, limited transportation, and insufficient storage facilities, all of which impede the delivery of filters to remote communities. Consequently, the combination of limited awareness regarding the importance of clean water and proper sanitation practices when using CVFs, along with financial constraints, hampers the uptake of these filters among vulnerable populations. Additionally, ensuring the availability of replacement filters and maintenance support is crucial for ensuring long-term sustainability.

However, there are opportunities for government agencies, non-profit organisations, and the private sector to collaborate in addressing these challenges. One such opportunity is the establishment of local production facilities for ceramic water filters (CVFs), which not only lowers costs but also generates employment in rural areas. By training local artisans in filter production techniques, communities can enhance their self-reliance. Moreover, involving community members in the adoption process cultivates a sense of ownership and responsibility. Implementing participatory approaches

that integrate community feedback and preferences can boost the acceptance and efficacy of CVFs. Additionally, the widespread use of CVFs holds promise for significantly reducing waterborne diseases, thereby enhancing public health outcomes in rural Nigeria. Furthermore, the durability and long lifespan of ceramic filters position them as a sustainable, long-term solution for water purification.

RECOMMENDATIONS

Advancing education and awareness initiatives regarding the significance of clean water, subsidising ceramic vessel filters (CVFs) for low-income households, and establishing local production facilities can improve accessibility to this vital technology through:

- The government has invested in purchasing ceramic vessel filters from Potters for Peace (PFP), an organization that advocates for the use of ceramic water filters. Engineers engineered these filters to eliminate bacteria, protozoa, and sediment from water. They are cost-effective to manufacture and widely used in many developing nations.
- Depending on community resources, training local artisans to craft ceramic filters locally could be viable. Organisations like Potters for Peace offer guidance and training materials for this purpose. This approach not only offers a sustainable solution but also empowers the community by generating local employment opportunities.
- When choosing a CVF, factors such as affordability, ease of upkeep, availability of spare parts, and specific water contaminants should be considered. Moreover, educating users on proper filter maintenance and usage is essential for sustained efficacy.
- Regular maintenance and replacement of filter components are imperative for continual effectiveness. Establishing local capacity-building initiatives and support systems can facilitate maintenance and repairs.

CONCLUSION

Ceramic vessel filters offer a promising solution to the challenge of providing clean and safe drinking water in Nigeria's rural communities. By providing affordable and effective water treatment at the household level, CVFs have the potential to significantly improve public health outcomes and enhance the quality of life for millions of people. However, their widespread adoption faces various challenges, including limited awareness, financial constraints, and infrastructural barriers. Nonetheless, by leveraging opportunities such as local production, community engagement, and health impact, the implementation of CVFs can contribute to significant improvements in public health and overall well-being. Addressing these challenges and seizing these opportunities requires a concerted effort from government agencies, NGOs, local communities, and other stakeholders to ensure the sustainable and equitable provision of clean water for all Nigerians.

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