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APPLICABILITY OF BIOLOGICAL SAND FILTERS (BSF) IN WATER DECONTAMINATION: A SYSTEMATIC LITERATURE REVIEW
SDG 6

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Introduction

Water is essential for life, but making sure everyone has enough clean water is becoming more difficult as resources become scarce and water quality worsens around the world. In many developing countries, poor sanitation leads to ongoing outbreaks of waterborne diseases. About 750 million people globally still do not have access to safe drinking water. In Brazil, for example, there are big differences in how water is treated from one region to another, which means rural and low-income communities often struggle the most. One promising and affordable solution is the use of biological sand filters (BSFs), which clean water by removing contaminants both physically and biologically. In this study, we review the current research to assess the effectiveness of BSFs in making water safer to drink.

Literature review

When we look at the scientific landscape, it becomes clear that there's a pressing demand for water treatment solutions that are both effective and affordable, especially in developing areas where traditional systems often fall short (SILVA et al., 2023). In this context, biological sand filters (BSFs) have really come to the forefront as a promising option. They're quite remarkable in their ability to clear out pollutants and infectious agents through a combination of physical and biological actions (BALDUINO, 2021; FONSECA, 2020). Indeed, numerous studies have consistently shown just how effective BSFs are at getting rid of microscopic nasties like bacteria and protozoa, which, as we know, are major culprits behind waterborne illnesses (ELLIOTT et al., 2015).

What's particularly interesting is how BSF technology continues to evolve, often by bringing in extra materials to boost their performance. For example, adding zero-valent iron (ZVI) has been demonstrated to significantly improve the removal of protozoan oocysts, while activated carbon and bone char prove quite adept at soaking up chemical contaminants such as fluoride and arsenic (GUTIERREZ et al., 2024; LUGO-ARIAS et al., 2019; FUNG et al., 2021). A key player in the long-term effectiveness of these filters is the formation of a biologically active layer, often called the *schmutzdecke*, which is absolutely vital for the oxidation and breakdown of contaminants (ELLIOTT et al., 2015). But it's not just about the technical specs; the real success of BSFs is deeply intertwined with social and cultural elements. This really underscores why community involvement, health education, and local training programs are so incredibly important for ensuring these filters have a lasting and positive impact (MOROPENG; BUDELI; MOMBA, 2021).

Method

Exploratory and qualitative research was conducted, searching for information on the topic in the Medline scientific database using the following descriptors: "biosand filter," "evaluation," and "efficacy." It includes articles published in English from January 2020 to December 2024 witch evaluated the effectiveness of biological sand filters for water decontamination.

Results or Expected Results

98 articles were initially identified and, based on the exclusion and inclusion criteria selected for this research, only 9 were selected to compose the results. Based on them, it was made a table comparing the methods and results of each. The findings were that BSFs demonstrate considerable effectiveness in mitigating microbiological contamination, particularly concerning bacteria and protozoa.

This foundational efficacy is further bolstered by innovative modifications, such as the integration of zero-valent iron (ZVI), which significantly amplifies the removal rates of resilient protozoan oocysts like *Eimeria* and *C. cayetanensis* (GUTIERREZ et al., 2024). Furthermore, the strategic inclusion of materials like activated carbon and bone char has proven instrumental in addressing chemical contaminants, including fluoride and arsenic, thereby broadening the scope of BSF applicability (FUNG et al., 2021; LUGO-ARIAS et al., 2019).

Beyond the technical performance, the success of BSF implementation is intricately linked to a confluence of socio-cultural and operational dynamics. Observations from the reviewed literature underscore that even highly effective filtration systems can be undermined by inadequate hygiene practices and improper water storage, leading to recontamination (MOROPENG; BUDELI; MOMBA, 2021). Moreover, while BSFs excel in removing suspended solids, their efficiency in eliminating dissolved nutrients and metals is comparatively lower, suggesting a need for complementary treatment strategies, especially in sensitive ecological contexts such as aquifer recharge zones (ZAREZADEH et al., 2018). These insights collectively emphasize that maximizing the public health benefits of BSF technology requires a holistic approach, integrating technical advancements with robust community engagement and educational initiatives.

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Conclusions or Final considerations

Biological sand filters (BSFs) emerge as a highly promising and accessible solution for enhancing water quality in vulnerable regions, exhibiting substantial efficacy in contaminant removal. However, realizing their full potential necessitates the implementation of integrated public policies that strategically combine technological advancements with robust health education and active community engagement, thereby ensuring their sustained effectiveness and long-term impact.

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