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Editorial: Emerging approaches for sustainable management for wastewater

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Editorial on the Research Topic
Emerging Approaches for Sustainable Management for Wastewater

Introduction

Water, one of the most precious natural resources for life of our planet, is indispensable for the endurance of every human, prosperity of our society, economic development, and social well being. The global demand for clean water resources has increased dramatically as a result of demographic shifts, economic expansion, rampant urbanization, and population growth, living standards, and expanding areas of irrigated agriculture. Therefore, the obstacle of water scarcity, and pollution of fresh water reservoirs, has become an imperative threat worldwide (Kumar et al., 2021; Li et al., 2022). The consumption of fresh water has increased twice quicker as the global human population increase and it is projected that more than 40% of the population around the globe will face water scarcity problems within the next 50 years. In order to mitigate the coming water crisis, wastewater reclamation, recycling, and reuse, has been considered as a substitute of fresh water to tackle the shortage in water supply providing water for different purposes, nutrients, and other value-added products. A huge volume of contaminated wastewater is generated from diverse sectors, such as agriculture lands, industries, municipal, and commercial areas. According to the United Nations report, in developing countries 80% of all urban and industrial wastewater is disposed into the aquatic reservoirs without any adequate remedies. Thus, providing good quality of water, adequate treatment, and sustainable wastewater management of wastewater is of great importance before disposal into the ecosystem to protect public and environment health and promote the sustainable development of the human being (Semaha et al., 2022).

Traditionally, the goal of wastewater treatment was to safeguard accessibility and management for all in a sustainable way. Various materials, processes, and technologies are nowadays available for achieving an efficient treatment and reclamation of wastewater and

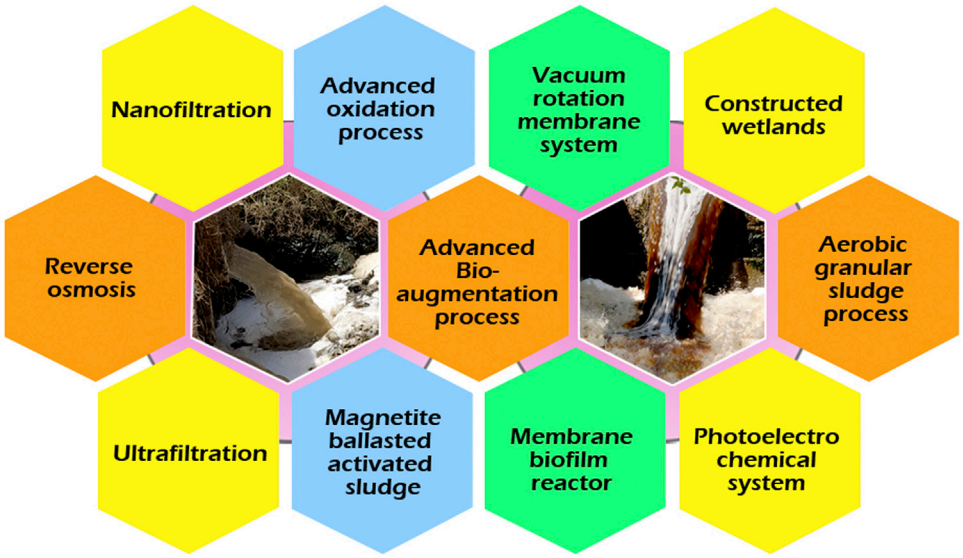

FIGURE 1
Emerging approaches used for wastewater management.

their reuse in different sectors to ensure public health and ecological safety. In last 2 decades, various decontamination approaches, such as coagulation–flocculation, ion exchange, adsorption, ultrafiltration, nanofiltration, advanced oxidation processes (AOPs), membrane bioreactors (MBRs), chemical oxidation, and advanced biological treatment approaches using algae, bacteria, fungi, and plants in combination are emerging to decontaminate polluted wastewater (Ashraf et al., 2021; Krishnan et al., 2023) (Figure 1). The recent advances and technological development in field of wastewater treatment, recycling, and reuse showed that a quality wastewater can be achieved, suitable for reuse in numerous application, such as aquaculture, industrial processes, agricultural irrigation, etc.

The main goals of this Research Topic (RT) are to compile the recent research and development, and challenges of efficient, sustainable, and innovative emerging technologies in area of wastewater treatment, management, reuse, and safe disposal with the ultimate aim of promoting the overall environmental sustainability of the wastewater management system. This RT comprises a total of 7 contributions (5 research articles and 2 review articles) by leading experts from around the globe in various fields of wastewater treatment. The following is a summary of the articles published in this RT.

Highlights From Articles Featured in This Research Topic

In the first review, Kumar and Arora critically discussed the biotechnological applications of potent ligninolytic enzyme, manganese peroxidases (MnPs), that are crucial for primarily degrading a wide range of recalcitrant contaminants including lignin, toxic dyes, mycotoxins, antibiotics, emerging organic compounds, and polycyclic aromatic hydrocarbons discharge in wastewater. Moreover, MnP has been used in pulp and paper production industries to reduce the amount of lignin components and chemicals in biopulping and biobleaching.

One of the review articles by Efrain Merma Chacca et al. focuses on the detection, presence, treatment and ecotoxicity in aquatic and terrestrial ecosystems of drugs tested to cure the COVID-19 pandemic. According to the data reviewed in the articles, tested drugs are existing in diverse environmental matrices, such as domestic water, common effluent treatment plants, wastewater treatment decentralised facilities, and surface water, which pose a serious health concern to environment and human. Integrated processes, such as algae treatment, photocatalysis, photodegradation, photo-Fenton, and advanced oxidation processes, seem to be the best alternative for treating antibiotics contaminated wastewater.

A study carried out by Maldonado et al. to improve the remediation of chloramphenicol and tetracycline by modifying three factors: plant biomass (10–14 g), antibiotic concentration (5–15 mg L^{-1} tetracycline and 10–20 mg L^{-1} chloramphenicol), and contact time (3–7 days). The study showed that the tetracycline was well eliminated than chloramphenicol, reaching extreme elimination efficiency of 64% and 84% with *Azolla* and *Lemna*, respectively. The results demonstrated that the selected plants species representing a cost effective substitute for elimination of antibiotic residues from polluted wastewater.

Percivall et al. developed a novel biobeads using sodium alginate, *Chlorella vulgaris,* and glomalin as a suitable secondary scaffolding medium to treat phosphorus-containing urban wastewater and simultaneously reduce the problem of eutrophication in marine and limnetic ecosystem. Study demonstrated that sodium alginate/glomalin matrix with immobilized *C. vulgaris* significantly reduced the phosphorus load up to (80%) after 9 days in the eutrophic solution. However, the nutrient removal efficiency and stability of developed biobeads could be meaningfully affected by light, pH, and salinity of the surrounding environment.

A very comprehensive study by Prakash et al. explored the integrated application of macrophytes (*Typha* sp. And *Phragmites*

sp.) and highly indicative zooplanktons (*Moina macrocopa* and *Brachionus angularis*) in constructed wetland for the decontamination of wastewater in 3-year time series study. The integrated application yielded up to 92% and 56% reduction in biochemical oxygen demand and total bacterial count, respectively along with significant rise in the dissolved oxygen content.

Bera et al. developed a highly potential bacterial consortium, SPB92, comprises *Kocuria rosea*, *Bacillus flexus, Bacillus tequilensis,* and *Pseudomonas stutzeri*, which cause decolorization and degradation of Acid Orange (30 mg/L) within minimal nutrition under static laboratory conditions at 23 h. Moreover, SPB92 could decolorized five additional azo dyes which are structurally similar to the Acid Orange. This indicates the noteworthy potential of SPB92 in management of textile wastewater discharged in open environment without adequate treatment.

Deepa et al. introduced an environment friendly approach for the synthesis of silver nanoparticles (AgNPs; 30–50 nm in diameter) from unutilized vegetable wastes peels of *Lagenaria siceraria* and *Pisum sativum* and assessed antimicrobial activity of synthesised nanoparticles against *Escherichia coli*. The production of AgNPs from household waste can be a sustainable approach for management of wastage in food industries and consequently reduce the environmental burden.

Concluding Remarks and Future Perspectives

The papers in this RT advances our understanding on the innovative and advanced strategies that can play a vital role in sustainable wastewater treatment and management to obtain safe reusable water, however, also on challenged and future research directions. As Kumar and Arora suggested that recombinant MnPs can be produced in huge quantities with enhanced stability and biodegradation efficacy. Efrain Merma Chacca et al. proposed the need of technological alternatives that allow the abatement of antiviral residues from polluted environment in a cost effective and efficient manner. Similarly, Maldonado et al. recommended the use of developed model based on the use of *Lemna* and *Azolla* as an alternative for the treatment of wastewater contaminated with antibiotic residues. Percivall et al. suggested that further research should be warranted to evaluate long-term impacts on soil quality and nutrient dispersal upon re-application phosphorus-containing wastewater treated by immobilized *C. vulgaris*. As strongly stated by Prakash et al. the integrated use of macrophytes planted constructed wetlands, a nature-based system, with inoculated by zooplankton will help in designing sustainable biological technology for the reclamation and on-site treatment of wastewaters. Bera et al. highlighted the importance of developed bacterial consortium could be served as a highly suited contributor for bioremediation of huge amount of intensive and coloured textile wastewater, which is a serious threat to the environment. Deepa et al. concluded that synthesis of AgNPs from vegetable wastes can be a useful in food waste management as well as preservation of vegetables from microbial contamination in the future. We hope the novel information afforded by the published articles in this RT will stand as a small but solid and appreciated contribution to the field of wastewater treatment and management by emerging approaches. Eco-friendly and cost-effective remediation approaches will also help in achieving the Sustainable Development Goals 3 and 6 (SDG3&6) established by the United Nations for the year 2030.

Author contributions

VK drafted the manuscript which all co-authors reviewed, and edited, and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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