Chapter 9
Potential of Agricultural Wastes as Alternative Biosorbents

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ABSTRACT

Agricultural wastes have excellent potential as substitute biosorbents to reduce pollution in the environment. These include organic contaminants, pesticides, dyes, heavy metals, and other impurities from soil and water. In the chapter, the authors focused on the adsorption capacity, remediation mechanism, and possible uses of agricultural wastes as biosorbents as well as their viability and efficacy. The biosorption capabilities of a variety of agricultural wastes, including crop residues, fruit peels, rice husks, and sugarcane bagasse, has been extensively studied. The processes of biosorption generally encompass ion exchange, complexation, physical adsorption, and chemical interactions between the target pollutants and the functional groups on the biosorbents. This study emphasizes the use of agricultural waste as an efficient alternative for artificial absorbents and promotes a circular economy by addressing environmental issues. Thus, the development of effective biosorption techniques using agricultural wastes is a pressing need for achieving environmental sustainability.

1. INTRODUCTION

Agricultural practices are integral to human society, providing sustenance and raw materials for various industries (Hemathilake & Gunathilake, 2022). However, they generate a substantial amount of waste that, when mismanaged, poses significant environmental challenges. In a world grappling with escalating

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pollution and dwindling natural resources, the potential of agricultural waste as alternative biosorbents for environmental remediation emerges as a compelling and underexplored subject (SUD et al., 2008).

This chapter delves into the realm of agricultural waste and its untapped capabilities as biosorbents, offering a sustainable solution for removing organic contaminants and heavy metals from soil and water. At the intersection of environmental science and agricultural innovation, this chapter explores the adsorption capacity, remediation mechanisms, and potential applications of agricultural waste as biosorbents, critically examining their viability and efficacy (F. A. Ahmad, 2023).

Agricultural waste comprises a wide array of materials, from the remnants of harvested crops to fruit and vegetable peelings left behind in food processing. The disposal of such waste can lead to air and water pollution, soil degradation, and the release of harmful chemicals. Furthermore, improper disposal practices can contribute to the emission of greenhouse gases, exacerbating the global challenge of climate change. In light of these challenges, the need for sustainable solutions to manage and repurpose agricultural waste becomes evident (Sadh et al., 2018).

Biosorbents, in the context of agricultural waste, offer a promising solution to this multifaceted problem. Biosorbents are biological materials with the capacity to adsorb pollutants from the environment, offering an environmentally friendly, readily available, and renewable means of pollution cleanup(Karić et al., 2022). They can target a wide range of pollutants, including pesticides, dyes, heavy metals, and various other impurities in aqueous solutions (Elgarahy et al., 2021). The mechanisms behind biosorbents' efficacy in pollutant removal are diverse, encompassing ion exchange, complexation, physical adsorption, and chemical interactions between the target pollutants and the biosorbent's functional groups (Dai et al., 2018).

Biosorbents present a dual solution, as they not only address agricultural waste problems but also combat environmental pollution (J. Wang & Chen, 2009). Repurposing agricultural waste as biosorbents promotes a circular economy, reducing environmental concerns while increasing the overall value derived from agricultural outputs (F. Ahmad & Zaidi, 2021). This approach aligns seamlessly with sustainable and green chemistry principles, offering an economical and environmentally beneficial remedy for soil and water pollution. Moreover, it reduces the need for artificial adsorbents, making the development of effective biosorption techniques using agricultural waste a contemporary imperative for environmental sustainability (F. A. Ahmad, 2023).

The potential of agricultural waste as alternative biosorbents, it begins by scrutinizing various agricultural wastes, such as crop residues, fruit peels, rice husks, and sugarcane bagasse, which have been extensively researched for their potential in sustainable pollution cleanup (Sen, 2023). Each of these waste materials is examined for its unique characteristics, adsorption capabilities, and potential applications in environmental remediation.

The core of this exploration lies in understanding how these biosorbents function in pollutant removal. Their efficacy in eliminating a wide range of pollutants, from organic contaminants to heavy metals, demands a thorough examination of the underlying mechanisms. These mechanisms, including ion exchange, complexation, physical adsorption, and chemical interactions, are elucidated to provide a comprehensive view of the biosorption processes at play (Raji et al., 2023).

Furthermore, this chapter underscores the significance of agricultural waste as an efficient alternative to artificial absorbents and traditional remediation processes. The synthesis of research findings, case studies, and practical applications demonstrates the real-world potential of harnessing agricultural waste for environmental remediation while addressing the broader context of sustainability.

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