# Chapter 11
# Synthesis, Properties, and Application of Bio-Nanocomposites:
## Application of Nanobiochar and Biochar Nanocomposites in Environment

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## ABSTRACT

*Modern society relies on nanobiochar and biochar nanocomposites as innovative materials to resolve major environmental issues alongside agricultural difficulties. Engineered biochar-based materials boost adsorption performance which makes*

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*them efficient tools for wastewater bioremediation mainly focused on heavy metal and organic substance elimination. Advanced surface properties coupled with improved porosity and nanoparticle functionalization allows them to efficiently adsorb pollutants which include arsenic and chromium along with lead, cadmium and copper. Research findings show nanobiochar exhibits better capabilities for extracting pollutants from water sources which renders them critical components in environmental sustainability operations. Nanobiochar proves crucial for agriculture by performing various functions outside wastewater treatment. Nanobiochar supports plant development through better soil nutritive value and enhanced nutrient absorption while maintaining soil acidity at stable levels. Nanobiochar functions as a soil additive that improves organic matter composition while preserving liquid retention while preventing harmful metal accumulation. Nanobiochar has demonstrated chemical residue removal ability by absorbing dangerous pesticide residues that target environmental toxicity. The antimicrobial capabilities of nanobiochar enable disease suppression in soil whereas chemical pesticides have less environmental benefits. kullanım of nanobiochar promotes beneficial microbial growth that upgrades fertilizer cycling operations while strengthening soil well-being. Through fertilizer application nanobiochar supports effective nutrient dispersal that prevents waste and decreases pollution impacts on the environment. Both nanobiochar and biochar nanocomposites serve as decisive elements for implementing sustainable environmental measures and agricultural practices. These materials show remarkable value by improving all elements of water purification and soil quality and crop productivity and microbial balance to resolve international concerns about environmental pollution and food shortages. Research development needs focused material optimization to establish these materials as crucial elements for ecological protection and resource management systems.*

## 1.0 INTRODUCTION

The worsening environmental problems which include soil degradation alongside water pollution and climate change escalate because of increasing population numbers coupled with urban development and industrial activities. The current situation requires innovative strategies which deliver both sustainability and performance for solving these problems (Dijoo and Khurshid, 2022). Biochar has become a promising solution because it serves various purposes in environmental management through its ability to sequester carbon and enhance soil quality as well as clean up pollution sources. However, conventional biochar often faces limitations in terms of performance, especially in complex environmental matrices. The regulated thermal decomposition of biomass feedstock, such as agricultural waste and other lignocel-

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