Microbes and Microbial Biotechnology for Green Remediation

Edited by

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Chapter 10

Microbial interaction of biochar and its application in soil, water and air

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10.1 Introduction

Environmental remediation is a great subject of research in terms of managing environmental deterioration. Pollution levels have been increasing over the last decades and are toxic for the environment and human health (Kuppusamy et al., 2016; Vilela et al., 2018; Wang et al., 2019). Contamination of soil and water environment has affected the environment, health, and food production (Godfray et al., 2010). Hence, to control the toxicity level, one needs to urgently switch to a remediation strategy to control further contamination in soil and water (Sarwar et al., 2017; Song et al., 2017; Wu et al., 2019; Yang et al., 2019). Bioremediation approaches are environment-friendly and economically sustainable methods for controlling pollution levels in a contaminated environment. Bioremediation of contaminated soil or water is a cost-effective and common method (Beesley et al., 2011). For this purpose, biochar application to bind pollutants has been in use, and it also promotes plant growth by stimulating ecological biodiversity.

Biochar is one such source of remediation with a wide range of sources of raw material used for maintaining soil fertility, which can decrease the level of pollutant (Abdul et al., 2017; Kanjanarong et al., 2017). Anthropogenic sources (industrial, agricultural, household) release pollutants that are toxic to the environment. Remediation of these organic and inorganic pollutant [benzene, dioxins, mercury, biphenyls, arsenic, polycyclic aromatic hydrocarbons (PAHs)] through biochar can help in the reduction of these contaminants via a bioremediation process (Beesley et al., 2011). Biochar is a carbon-rich biomass generated from thermal treatment. Thermal treatment includes pyrolysis or thermal liquefaction, thereby categorizing the biochar as pyrolysis biochar or liquefaction biochar, sometimes referred to as hydrochar (Leng et al., 2020). These treatments offer the biochar produced with exclusive properties that encompass carbon content, structure, porosity, pH, surface charge (functional groups), reactivity, hydrophobicity, and electron conductivity (Kavitha et al., 2018). It has significant adsorption capacity due to its peculiar physiochemical properties. These properties vary with respect to the feedstock used and the treatment method undergone to form the final product that is biochar (Sun et al., 2020). Biochar application on soil has been shown to reshape soil characteristics and influence the activity of the microbial community that catalyzes soil organic content and function (Paz-Ferreiro et al., 2014). Biochar manifests to improve soil structure and functionality in a lucrative manner. Biochar usage has many positive effects on soil and microbial community; hence biochar is an effectual tool for remediation purposes. However, the exact mechanism of biochar−soil microbe interaction is still unclear (Zhu et al., 2017). This carbon-rich material has various applications, serving as an adsorptive substance for numerous contaminants in the environment (Fig. 10.1). These contaminants belong to a wide range of compounds which include heavy metals, dyes, microbes, chemicals from manufacturing units and industries, chemicals utilized in agricultural sector, aromatic compounds, and organic acids. Biochar also utilized as catalysts for reactions in manufacturing (Singh et al., 2020). It is regarded as a substitute for activated charcoal and/or activated carbon due to its adsorptive characteristic and abundance. However, amendments to trigger and enhance the adsorptive feature increase the cost of production, but the reusability and recyclability of biochar balances the cost increase for production (Inyang & Dickenson, 2015). Various studies on biochar structure, physiochemical properties, and its impact on soil properties are available in the literature (Ahmad et al., 2014; Ameloot et al., 2013; Chen & Yuan, 2011; Lehmann et al., 2011), although there is a research gap on biochar−microbe

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