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Green Waste and Plant Growth-Promoting Rhizobacteria: A Dynamic Duo for Bioremediation and their Strengthened Collaboration

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Abstract

These are forced to enter into the food chain as they tend to accumulate in the agricultural soils. In order to eliminate these pollutants from the soils the bioremediation will be an efficient tool and this can be achieved by plant growth promoting rhizobacteria and by green wastes. In this study the plant growth promoting rhizobacteria (PGPR) and green wastes are evaluated for their effectiveness in bioremediation the toxic contaminants. Green wastes are rich sources of naturally occurring polyphenols which are potential eliminating agents of these pollutants, they can perform metal chelation, reduction, antibiotic properties, adsorption, complexation and by supplying the nutrients. The increasing anthropogenic and technogenic activities to compensate the raising population and unending demands of humans ended in severe pollution and detrimental damage to the environment. This environmental pollution due to lethal pollutants, toxic heavy metals and organic wastes has been drastically affecting the ecosystem of the living organisms. Green wastes are rich sources of naturally occurring polyphenols which are potential eliminating agents of these pollutants, they can perform metal chelation, reduction, antibiotic properties, adsorption, complexation and by supplying the nutrients. However, PGPRs are well known plant life saviors from various biotic and abiotic stresses; they are also the bioremediation agents as they perform heavy metal elimination by various methods.

Keywords: Bioremediation; Bio resources; Green waste; Heavy metals; PGPR; Complexation; Chelation

Introduction

In recent years, the detrimental effects of pollution on our environment have become increasingly evident. As a result, there is a growing need for sustainable and efficient methods of bioremediation to mitigate the impact of pollutants. Green waste, comprising organic materials such as leaves, branches, and grass clippings, offers a promising solution for environmental cleanup. When combined with plant growth promoting rhizobacteria, a group of beneficial soil microorganisms, their synergy enhances the bioremediation potential significantly [1]. This article delves into the incredible capabilities of this powerful duo and explores how their combination can revolutionize bioremediation efforts. Use of peel leftovers from a variety of fruits, vegetables, and plants adsorption is an environmentally friendly, versatile, simple, and economical method due to having the benefits, such as their wide availability, straight forward treatments, biodegradable capacity, and variety of sources, waste management, and high efficacy in the removal of pollutants, such as heavy metals [2].

Green waste: nature's restorative resource

Green waste is an abundant and renewable resource that arises from various activities like landscaping, gardening, and agricultural practices [3]. Traditionally, green waste has been considered a burden and discarded in landfills, contributing to greenhouse gas emissions and leachate formation. However, recent research has shed light on its immense potential in bioremediation. Green waste contains organic matter, essential nutrients, and a diverse range of microorganisms, all of which play crucial roles in the remediation of polluted environments. The organic matter acts as a carbon source, providing energy for microbial degradation of pollutants. Additionally, the microorganisms present in green waste produce enzymes that break down complex pollutants into simpler, less harmful compounds. This natural process, known as microbial degradation, can effectively remove contaminants from soil, water, and air [4].

Plant growth promoting rhizobacteria: nature's allies

Plant growth promoting rhizobacteria are a group of beneficial bacteria that colonize the root systems of plants. They form a symbiotic relationship with the plant, providing numerous benefits, including enhanced nutrient uptake, disease resistance, and stress tolerance. Moreover, certain strains of PGPR possess remarkable abilities to degrade pollutants and promote bioremediation PGPR interact with plants through various mechanisms, such as the production of phytohormones, siderophores, and enzymes [5]. These compounds stimulate plant growth and development while also facilitating the breakdown and detoxification of pollutants. PGPR can degrade a wide range of contaminants, including hydrocarbons, heavy metals, pesticides, and organic pollutants. Furthermore, they enhance the plant's natural defense mechanisms, enabling it to withstand toxic environments and support the overall bioremediation process [6].

Enhanced synergy: green waste

The combination of green waste and PGPR creates a synergistic effect that amplifies their individual bioremediation capabilities. When green waste is incorporated into polluted soil or water, it provides a nutrient-rich environment that supports the growth and activity of PGPR [7]. The bacteria, in turn, enhance the decomposition of organic matter, accelerating the biodegradation of contaminants.

Additionally, PGPR secrete specific enzymes that break down complex pollutants more efficiently, further facilitating the detoxification

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process [8]. Furthermore, the presence of green waste promotes the establishment and colonization of PGPR in the rhizosphere, the zone of soil surrounding plant roots [9]. The root exudates released by plants act as a food source for the bacteria, fostering their growth and multiplication. As the PGPR population increases, the bioremediation efficiency also escalates, leading to a faster and more comprehensive cleanup of polluted environments [10].

Conclusion

The combined use of green waste and plant growth promoting rhizobacteria holds immense promise for bioremediation efforts. Their enhanced synergy offers an environmentally friendly, cost-effective, and sustainable approach to restore contaminated ecosystems. By harnessing the power of nature's allies, we can turn waste into a valuable resource and combat pollution effectively. Hence, the farmers are forced to apply harmful inputs to their crop fields which in turn leave the unavoidable toxic pollutants into the ecosystem. In fact, the reclamation of the degraded soil is an expensive way and needs multifactorial actions from various aspects. These pollutants are threat to Mother Nature and all living organisms. Therefore, elimination of these pollutants must be achieved unconditionally; bioremediation is an efficient way to fulfill the termination process. Bioremediation is a process where the harmful materials are stamped out from the ecosystem; it can be acquired efficiently by the usage of plant growth promoting rhizobacteria and green wastes like orange peels, pineapple peels and citrus peels. In this article it is well defined and explained about the process, methods, applications and detrimental effects of these aspects. The PGPR micro biome can be a sustainable approach to banish the toxic pollutants, support plant growth in stressful conditions and soil reclamation.

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