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Phytoremediation of Saline Soils Containing Metals

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Introduction

As a lot of industrial companies settle in or around saline ecosystems, spills and releases of pollutants like metals are common. Metal contamination is a significant danger for people and environments. In accordance with sustainable development, eco-friendly and inexpensive methods for removing metals or limiting their spread in the environment are provided by nature-based solutions and biological tools like phytoremediation. The production of auxins, siderophores, or extracellular polymeric substances to enhance phytoremediation is just one example of many plant-associated microbes potential plant-growth-promoting (PGP) effects. Today, halophytes are promoted as effective phytoremediators for metal-contaminated saline environments, such as coastal areas, but little is known about the bioaugmentation potential of their associated microbes.

Description

We go over the studies that looked at microbes that were associated with halophytes and how they helped plants grow. Bio augmented phytoremediation's limitations and applicability to saline ecosystems are also the subject of our discussion. There are a lot of heavily polluted coastal areas. There are right around 620,000 km of shores around the world and north of 33% of the all-out human populace lives inside 100 km of the coast. Terrestrial and marine organisms rely heavily on the intertidal ecosystems for their entire or part of their life cycles. Metals continue to accumulate in the food chain of surrounding ecosystems despite the fact that coastal environments serve as buffers at the land–sea interface, preventing the spread of contaminants to the ocean. However, the levels of contamination are such that the retention effects of these ecosystems are frequently insufficient. Metal pollution in coastal areas is now a major concern because it affects marine organisms, invertebrates, plants and microorganisms and is harmful to human health [1].

So, over the past few decades, scientists have paid a lot of attention to biological remediation methods for removing metals from coastal wetlands, especially mangroves, estuaries, salt marshes and forests. Since the costs and environmental benefits of metal contamination remediation have increased, particularly in highly industrialized areas of developing and developing nations, biological solutions have attracted interest. The escalating commercial issues, particularly in the countries of Northern America, have fuelled the growing interest in phytoremediation strategies over the past two decades. A method of phytoremediation called phyto extraction of metals involves using plants that preferentially accumulate these elements in their aerial parts to absorb metals from the soil. The metals may be extracted from plant biomass in forms that could later be used for a variety of industrial applications. Metal phyto stabilization, on the other hand, employs plants that decrease "the mobility and bioavailability of metals within the environment, thereby preventing their migration to groundwater or their entry into the food chain." People's health, work output and social relationships have all improved as a result of phytoremediation and, more specifically, the creation of green spaces [2].

Furthermore, scientific publications are increasingly recommending biological remediation methods as cost-effective solutions. The costs/effectiveness ratio of phytoremediation was higher than in the case of excavation and disposal or soil washing only for low contamination levels for duration of five years of treatment. In fact, the costs of phytoremediation applications are particularly low in comparison to conventional methods. To speed up and improve the process, these authors suggest combining phyto extraction and physicochemical methods. The phytoremediation yield could, however, be accelerated and enhanced by microbes. It is known that many microbes associated with plants boost plant growth and stress resistance. It is possible to combine phytoremediation with microbial remediation, which is the process of removing contaminants from the environment through the use of microorganisms. In point of fact, microbe-assisted phytoremediation methods involving plants and bacteria or fungi have been proposed as a cost-effective and dependable strategy for increasing plants intrinsic bioaccumulation capacities. Biotransformation, bioleaching, bio sorption, bioaccumulation and bioprecipitation are the primary strategies that microbes have developed to deal with soil contaminants. Consequently, microbes are frequently pursued as intriguing bioremediation targets [3].

The capacities of halophytes to adapt to elevated degrees of metals have been broadly examined . Indeed, we found 27,400 results when we used the search term "halophyte OR halophytes AND (metal OR metals)" on Scholar Google. This group of plants, which make up between 1 and 2% of the world's flora, has a lot of interesting properties that can be used in food, pharmacology and energy applications. Some species have already been recommended for the phytostabilization or phytoextraction of organic and inorganic pollutants. During the 2000s, specialists started to read up halophytes-related microorganisms for their bioremediation potential and the quantity of distributions on their utilization as plant-inoculants just expanded in the last part of the 2000s/mid 2010s, yet concentrates on fundamentally centred around saline-impacted soils as opposed to metal-tainted saline soils. However, interesting plant-growth-promoting (PGP) properties of halo tolerant microbes that could also benefit plants under metal stress have been shown in numerous papers devoted to the restoration of salt-affected agricultural soil functions. These microbes show multiple PGP effects and metal-tolerance strategies due to their halophilic or halotolerant adaptations, highlighting their potential for treating metal-contaminated saline soils. Despite warnings about the effects of contaminants spreading in the oceans, microbe-assisted phytoremediation applied to metal-contaminated coastal environments still lacks the knowledge necessary for proper use. In addition, despite the large number of experiments carried out in this direction, we are aware of no specific review that has examined the possibility of using halophyte-associated microbes as inoculants to boost the efficiency of halophyte phytoremediation in metal-contaminated saline soils. In fact, the majority of the research on PGP microbes was examined in relation to metal contamination in non-saline sites. A few surveys concerned applications to salt-impacted destinations by utilizing halotolerant microbes for horticulture however didn't foster their true capacity to improve metal phytoremediation.

The current research on the potential of halophytes and the microbes that are associated with them in the phytoremediation of metals is the focus of this review the strategies these halo tolerant microbes use to deal with metals and boost plant growth; how plants can benefit from using a microbial inoculum that combines bacteria and fungi and the limitations and advantages of microbe-

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assisted phytoremediation applied *in situ*. In order to better contextualize their significance in the optimization of metal-phytoremediation strategies applied to saline environments, the most common PGP effects, which were described in several publications, will be briefly discussed here. Clearly, this is the first review that focuses on bioremediation using the remediation potential of halophile plants and microbes in saline environments contaminated with metals. This work offers well-reasoned perspectives on the use of microorganisms in phytomanagement techniques in light of the magnitude of metal pollution on the planet's coasts. It also brings to light the obscure aspects of these kinds of applications that have yet to be clarified by scientific research. The number of studies and science projects on local metal-polluted sites differs between nations, according to a systematic analysis of publications investigating the degree of each nation's research interests in metal phytoremediation [4].

In addition, Guarino and Sciarrillo noted that environmental politics in Italy incorrectly choose expansive conventional techniques over biotechnologies like microbial-assisted bioremediation due to an overestimation of the pollution risk based on total metal content rather than bioavailable fraction. In fact, Summersgill emphasized the cost differences between bio-inspired alternatives and conventional methods. For instance, the average cost of off-site incineration is 885 euros per m3, while the average cost of off-site biological treatments is 167 euros per m3. Thermal treatments cost an average of 238 euros per m3, while phytoremediation costs an average of 122 euros per m3. Costs for *in-situ* bioremediation were even lower, averaging 73 euros per m3. Another illustration of this is that one of the largest phytoremediation projects was carried out in the Huanjiang region, which is a highly polluted area that is also contaminated with Cd, Pb and As. It cost only USD 37.7/m^3. The selection of suitable treatments for metal-contaminated sites should be brought to the attention of policymakers by this [5].

Conclusion

As a result, many of the studies that were reviewed here have shown that using one or more microbes to improve the phytoremediation process has the potential to reduce plant metal stress, boost plant growth and extract or stabilize metal pollutants, especially in saline areas. By conducting field trials when the effectiveness of the plant–microbe system has already been evaluated and by evaluating the long-term effects on the indigenous microbial and plant communities, researchers must continue to fuel knowledge regarding these techniques species- and site-specific applicability and predictability

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Conflict of Interest

None.

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