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EVALUATING THE MEDICINAL AND AROMATIC PLANTS' CAPACITY FOR PHYTOREMEDIATION

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INTRODUCTION

Heavy metals are dispersed globally and regionally as a result of fast modernization, urbanism, and agricultural use, causing severe environmental contamination like As, Pb, and Cd, that only occur in naturally low amounts but are a major environmental problem. An international issue is the increasing ecological burden brought on by human, agricultural, and industrial activity, municipal and energy sources, as well as the pollution of both water and soil with heavy metals and metalloids. A strategic issue of critical relevance now is promoting the healthy and synchronized development of the economy and the environment. Based on a recent study, one of the key factors influencing the development of the economy and the environment is industrial by - product (industrial wastewater, gases, dirt, and fire) (Rao and Yan,2020). This article briefly discusses the advantages of growing medicinal and aromatic plants for long-term phytoremediation.The potential consequences of heavy metals on land, the ecosystem, and flora will be examined in this study. Along with the significance and advantages of plants (like citronella, tulsi, lemon grass, Mentha, palmarosa, and vetiver, among others) for self-sustaining bioremediation, the different optimization schemes, mechanisms, phytochemical constituents, and attributes implicated in bioremediation and heavy metal high energy accumulation are also critically examined. The article presents a novel perspective, a novel research direction, and a large knowledge gap on long-term phytoremediation employing medicinal and aromatic plants and its strategy.

PLANT DEATH ATTRIBUTED TO HEAVY METAL POLLUTION

The overall geographic area of the planet is significantly contaminated by heavy metals. Nowadays, a significant portion of soil and water pollution comes from heavy metals and metalloids. The ecosystem's two main land- and water-dependent components are human civilization and agriculture. Regrettably, due to a variety of anthropogenic activities, these variables are rapidly becoming harmed, deteriorated, contaminated, or polluted. To maintain or improve plant tolerance to a particular metal stress, plants have a complex, linked sequence of chemical, chromosomal, physiologic, and architectural processes (Maleki et al., 2017). Plants have evolved a system to sequester metals into certain organelles (mostly in vacuoles) and separate them from all other essential cellular

organelles when exposed to heavy metal stress.

PHYTOREMEDIATION- A sustainable method of reducing environmental contamination

In the process known as phytoremediation, hazardous substances or pollutants are either either directly or indirectly removed from disturbed ecosystems, including such soil or water. Nowadays, phytoremediation is gaining popularity as a less invasive, environmentally benign, socially acceptable, and economically advantageous approach to environmental cleaning. For the elimination of metals as well as other toxicants from polluted soil and water, existing traditional approaches are too expensive and impractical. Natural environmental conditions can be preserved using the phytoremediation approach. Of the several clean up techniques, it is the least harmful. The fundamental idea underlying phytoremediation would be that vegetation may remove harmful substances from the soil, transform them into less harmful forms without compromising the food supply, and provide financial advantages. Plant-based remediation is more practical and sustainable than any other strategy since it doesn't degrade the soil's physical or biological qualities and, over time, actually enhances the soil's quality (Schnoor *et al.* 1995).

Phytoremediation techniques of Plant for removing heavy metals

According to their unique ability to adapt to harsh settings, plants can be divided into ridge vents, signs, and accumulators. Across a wide range of soil depths, excluders successfully limit iron transmission and keep low metal concentrations in their shoots. While accumulators accumulate far more elements in plant aboveground organs than indicators do, indicators often accumulate metals at amounts that are similar to those found in the soil.

Key Players in Phytoremediation

Several MAPs have shown considerable promise in phytoremediation studies:

Chamomile (*Matricaria chamomilla*): Known for its calming properties, chamomile is also effective at absorbing heavy metals such as cadmium and lead from contaminated soils.

Lavender (*Lavandula angustifolia*): This fragrant plant is not only popular in aromatherapy but also proficient at removing heavy metals and improving soil health.

Peppermint (*Mentha piperita*): Used widely for its soothing effects on the digestive system, peppermint has demonstrated an ability to uptake significant amounts of heavy metals and organic pollutants.

Thyme (*Thymus vulgaris*): A staple in culinary and medicinal applications, thyme has been found to be effective in the phytoremediation of soils contaminated with heavy metals.

Calendula (*Calendula officinalis*): Known for its skin-healing properties, calendula also excels in extracting heavy metals from the soil.

The possibility of lengthy phytoremediation via medicinal plants

The viability of medicinal herbs as phytoremediators has previously been well researched. Several plant species are grown in addition to food crops specifically for their metabolites. Due to their special usage in the creation of plant oils, perfumes, products for personal care, etc., they are known as "aromatic plants". These crops have a supplementary position in relation to food plants for bioremediation since they are not

directly connected to the food chain. Many aromatic plants have recently been examined for their potential for phytoremediation. The Poaceae, Asteraceae, Lamiaceae, and Geraniaceae families have produced the most promising medicinal and aromatic plants for bioremediation of heavy metal polluted environments. These plants provide a safer, more affordable, and significantly more environmentally friendly option. However, their essential oil output, which is their main product, is generally utilised for non-edible uses, such as in the pharmaceutical, food processing, perfumery, detergent, and insect sectors. It has frequently been recommended that heavy metal-contaminated lands be used to grow non-edible commercial aromatic crops since it is both profitable and practical (Lubbe and Verpoorte 2011).

CONCLUSIONS AND OUTLOOK FOR THE FUTURE

The potential for using aromatic plants in the phytoremediation of locations with heavy metal contamination is quite high. They operate as potential phytostabiliser, hyper accumulator for certain heavy metals, bio-monitors, and aerotolerant metallophytes. Heavy metal stress has been found to increase the essential oil proportion of several aromatic crops. Hence, cultivating these plants in polluted areas might be advantageous economically. Via phytoremediation, the "phytomanagement" idea has recently gained popularity. Further study is required to fully utilise the phytoremedial capability of aromatic plants for the phytomanagement of heavy metal polluted environments, which might result in "Ecofriendly scented innovation." Cost-benefit ratio may be enhanced with the least chance of contaminating the food chain by using aromatic plants to clean up polluted locations. Nevertheless, in addition to this, long-term monitoring field studies are required to evaluate the increase in soil quality and to take into account the associated risk factors. Also, multidisciplinary efforts must be undertaken in order to do more thorough study in order to comprehend the mechanism by which these plants absorb heavy metals, their pattern of translocation, and the destiny of heavy metals in plant components. In field tests, perennial aromatic plants with large biomass and the ability to produce several harvests each year should be tested for their phytoremediation capability. Overall, the fact that they are non-food crops and that aromatic plants may yield high-quality essential oils makes them a good choice for phytoremediation of heavy metal-contaminated locations. In-depth study in this field may soon result in a workable, affordable, and prosperous technology.

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