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Mycoremediation of Heavy Metals in Marine Ecosystems Using Fungal Endophytes

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Abstract

Mycoremediation is a form of bioremediation in which decontamination of the environment can be done. There are multiple gene regulation processes involved in this context that are responsible for enhancing the barrier against heavy metals. This study discusses some crucial aspects of mycoremediation and also the process of heavy metal exposure in the marine ecosystem. In situ aerobic bioremediation has been discussed in this study which more or less depends on the advanced technologies. Reduction of genotoxicity is the main theme of this study which occurs by various types of heavy metals. This study also discusses some crucial aspects of negative impact of metals in the marine ecosystems with the aid of measuring their percentage. Toposheet value of marine ecology has also been discussed in this study. Endophytic fungi act as the mycoremediation factor in this study by which adverse effects of biodiversity can be understood. This study further discusses the process of the waste accumulation and control by the process of mycoremediation. The study included various types of endophytic fungus exemplified by- Penicillium Rubens, Pleurotusostreatus, Emericella and Aspergillus.

Keywords

Biodiversity, endophytic fungi, marine ecosystem, mycoremediation.

INTRODUCTION

Heavy metals contamination in the soils may increase risk that is the main theme of this research. Pollution is a grave concern in this scenario. The poor quality of waste materials increases heavy metals in the sea by which marine ecosystems become disbalanced. According to a ***WHO or world health organization-*** 2.2 billion people do not have the access to use safe water services in their daily life. It has happened only due to the changes in the ecosystem of the marine environment. The anticipation of 2025 shows 50% of the world population will be living in the region where water stress can take place. Mycoremediation is one of the crucial processes by which heavy metals can be isolated. In the process of mycoremediation, fungal ***endophytes*** are frequently used in a large array. The endophytes are the fungi that belong to the family of- ***Ascomycota.***

All of the fungal endophytes make a symbiotic association with stems, fruit leaves and other organs of various plants. Mycoremediation can be ecofriendly, economical and an effective strategy to combat ever increasing problems in the marine ecosystem. In general, robust growth of fungal ecosystem encounters for reducing heavy metals in the marine ecosystem with the aid of ***robust growth, high surface area and volume ratio, adaptability to fluctuating temperature and pH.*** Fungus also has the property of acting as a bioreactor by which microbial growth can be enhanced in this context. The most important fungus in this scenario is filamentous fungi which causes bioremediation to heavy metals in this scenario. ***Hg remediation*** is also the central process in this study because, marine system is more susceptible to ***Hg contamination.*** This study discusses some crucial aspects of bioremediation of heavy metals by endophytic fungi with their huge array of species.

THE CONCEPT OF MYCOREMEDIATION IN MARINE ECOSYSTEM

Mycoremediation is known as fungi remediation and it is the form of bioremediation, which has the tendency to use fungi instead of bacteria. According to [1]. (2019), mycoremediation is enabled to offer an effective and sustainable way for decomposing waste than many other traditional bio remedial processes. Mycoremediation of agricultural wastes, such as herbicides, cyanotoxins and pesticides makes a negative impact on the marine ecosystem. Mycoremediation is an eco-friendly, economical and effective strategy to combat increasing water and soil pollution. Increasing the growth of fungus and increasing the production of extracellular ligninolytic enzymes in the large area is responsible for arising critical situations. Apart from that, fluctuating pH, metal-binding proteins and resistance of heavy metals, fungi are responsible for increasing numerous pollutions in the marine ecosystem.

Identification of the role of different fungi is responsible for harmful pollutants, such as pesticides, herbicides, antifungal drugs, insecticides, aromatic hydrocarbons, detergents, heavy metals and cyanotoxins. It has been identified that heavy metals are accountable for affecting the function and structure of the fungal cell membranes. Moreover, it is responsible for affecting the activities of different ligninolytic enzymes. Mycoremediation of PAH by ***Pleurotusostreatus*** helps in the activity of manganese peroxidase activities, fungal biomass, and microbial activities in the marine ecosystem ([1].2019). Moreover, elevation rates in fungal biomass and manganese peroxidase activities are significantly responsible for increasing the rate of soil and water pollution. The deposition of heavy metals is responsible for increasing threats to human health and

biodiversity.

THE NEGATIVE IMPACT OF HEAVY METALS IN MARINE ECOSYSTEM

Heavy metals are responsible for making an adverse impact on human health and biodiversity. According to [9]. (2021), there are numerous heavy metals, such as copper, cadmium, silver, lead, chromium, nickel, and many others. These harmful metals enter the water and soil through different natural activities and humans. These metals enter the human body through the consumption of food and water. Heavy metal toxicity has been proved as a major threat to marine biodiversity. These elements work as pseudo-elements, which is responsible for making a negative impact on water. Heavy metals are identified as those metals, which have more than 5 gm/cm of density and it makes a negative impact on the living organisms and environment. These metals are proved as noxious, which have threshold concentration values.

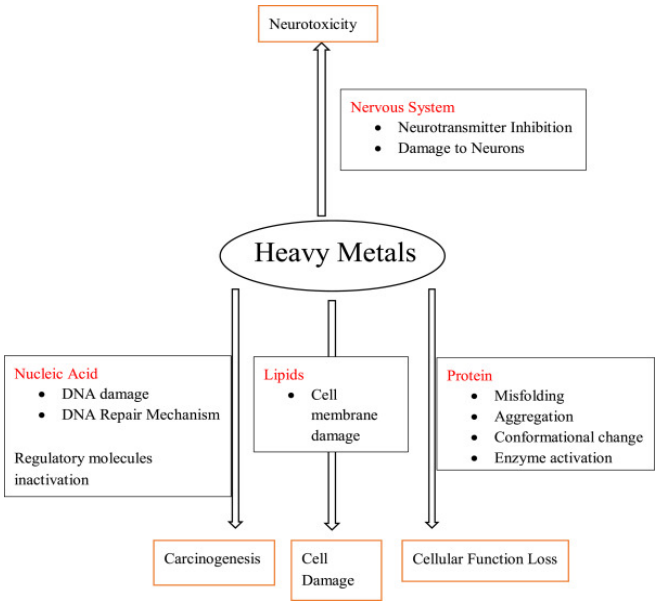

Figure 1: Negative impact of heavy metals in the marine ecosystem
(Source: [7].2019)

According to the above-mentioned picture, heavy metals are responsible for making a negative impact on the nucleic acids, lipids, and proteins, which is responsible for the loss of cellular functions and cell damages. Identification of these negative impacts of heavy metals made a negative impact on marine biodiversity.

GENE REGULATION IN FUNGAL ENDOPHYTES

In case of fungal endophytes, biotic and abiotic stresses are more or less intermingled to a large extent. As per the view of [8]. (2020), heavy metals can be reduced in the marine ecosystem by the alteration of gene expression of fungal endophytes. Gene regulation of fungal endophytes is more or less intermingled with the aid of transcriptional changes ([12]. 2021). Transcriptional factors become altered in the fungal endophytes in exposure to the heavy metals ([5]. 2019). The study shows a resistance activity in this scenario by minimizing the detrimental effect of heavy metals. The gene profiling system is now in the level of undiscovered but still some study is going on. It has been seen that production of new types of protein enhances the resistance activity of some fungal endophytes. RT PCR, transcriptome profiling and also microarray are the process of detecting the gene regulation and their expression at the molecular level. Plant microbe interaction in the body of fungal endophytes is the main theme of understanding in this scenario.

A transcriptome analysis of marine endophytic fungi shows that they have biologically active secondary metabolites which have the power to mitigate the heavy metals from the marine ecosystems. Ethyl acetate assay in this study shows that p 53 signaling becomes enhanced by the application of their signaling. As per the view of [10]. (2020), there are 26 proteins that have played a role in resisting various heavy metals by the activities of cytochrome P450. HIF-1 signaling, necroptosis and focal adhesion plays an important role in this scenario.

Transcriptional mis regulation can also be altered in the endophytic fungi by changing their habitat from soil to marine ([3]. 2020). Amplification of ribosomal region of the endophytic fungi incorporated with ITS or Internal Transcribed Spacers. They also have a sequence known as BLAST by which they performed their role ([11], 2019). Natural bioactive products and biocontrol of plant pathogens is the primary role of endophytic fungi by changing activity of protein synthesis. Detoxification protein originated from the translational machinery exemplified by- anti deoxynivalenol.

RESEARCH METHOD AND TECHNIQUES

The present study is following some significant methods for the identification of the negative impact of heavy metals on marine biodiversity. Relevant scientific research papers have been introduced with a major database for the identification of the negative impact of heavy metals. Identification of the toxic factors of heavy metals helps to understand the adverse effects of heavy metals in marine ecology. Analysis of **water quality and analysis** of sample spring helped to identify the negative impact of heavy metals for making a negative impact on the marine ecosystem. According to [4]. (2018), ***ArcView 3.2a software*** has been used for the identification of the **toposheet value** of marine ecology. This method has been determined to select a sample site. Throughout the research process, eight different samples have been used for the identification of the negative impact of heavy metals in water. **Eight** different sample sizes, like **Wasak Nag, Koel, Halidder** and many others helped to analyse the quality of water, to determine the effects of heavy metals on fungal endophytes. The collected water is sent to the hydrological laboratory for identification of the waterborne disease, which is responsible for negatively

impacting biodiversity. According to [2]. (2018), the "American Public Health Association " took the responsibility to deteriorate water quality, which has a negative impact on marine ecology. The presence of Ligninolytic enzymes in the degradation of heavy metals is responsible for creating oxidative stress, which is responsible for deteriorating the water quality in the marine ecosystem.

FINDINGS AND ANALYSIS

According to the research method, identification of the negative impact of heavy metals in marine ecology is responsible for deteriorating the water condition. According to [6]. (2021), heavy metals, such as lead, manganese, and copper are responsible for making a negative impact on the fungal endophytes. Above mentioned heavy metals are responsible for negatively impacting the ***Aspergillus niger, Fusarium species, Penicillium Rubens, Pleurotusostreatus, Emericella species, Trichodermaharzianum*** and many others. According to [7]. (2019), heavy metal toxicity is accountable for making a terminal effect on the microorganisms in the water. Heavy metal toxicity involves different mechanisms for reducing the bioavailability of the different heavy metals. Identification of the biochemical and physiological properties of heavy metals is important to know. Different heavy metals such as cadmium (Cd) and Chromium (Cr) are highly responsible for negatively impacting water biodiversity.

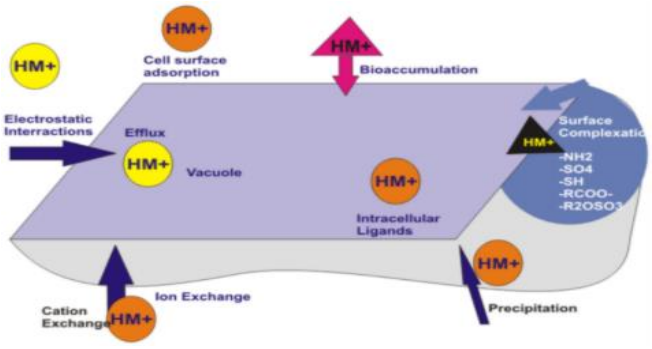

Figure 2: Mechanisms of heavy metals by microorganisms (Source: [2].2018)

According to this analysis process, it has been identified that there are possibilities to change the structure of Chromium. Moreover, denaturation and damage of oxidative activities are highly responsible for affecting DNA phosphate groups in the water. According to ***Haber-Weis reactions and Fenton reaction*** is enabled to carry soluble electrons. Moreover, Aluminium is responsible to stabilise superoxide radicals for several configurational changes. Moreover, it is responsible for creating ion imbalance in the cell surface.

Besides these, lead and cadmium pose devastating effects on microbes, membranes, and damaged cells. Eventually, it deteriorates the conditions of DNA structure. Eventually, it is responsible for the metal displacement. The metabolism, microbial growths and morphology affect ligand interactions or native binding sites. Eventually, oxidative phosphorylation's, inhibition of enzyme activities is responsible for functional disturbances.

CONCLUSION

This study shows that there are heavy metals- such as lead, cadmium, mercury and others that have a role to damage cells of a variety of organisms. Not only can that DNA condition be deteriorated in this context. A proper assay of mycoremediation causes production of various types of proteins that have a role in minimizing the activity of heavy metals. DNA denaturation can be controlled by production of anti- protein which is produced from fungal endophytes. It can also be observed from this study that endophytic activity can also enhance microbial growth which completely acts as a barrier for fighting with all of these heavy materials. Oxidative phosphorylation is the main cause by which heavy metals are restricted and compartmentalization occurred in the cells of marine organisms. Fungal biomass is the main soldier by which detrimental activity of heavy metals become restricted. Degradation of various kinds of heavy metals is only caused by ligninolytic enzymes which are present in the hyphal cells in a large array

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