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**INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI**

**Unravelling the characteristics of beneficial bacteria isolated from  
a polluted site and their application in soil quality enhancement**

*A thesis submitted*

*By*

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## Abstract

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In today's world, emerging economies such as India face a greater challenge toward sustainable agriculture. Farmers have been encouraged to use chemical fertilizers and pesticides indiscriminately to grow more food in less area. As a result, the yield has increased, but these benefits have been negated by environmental damages. It also harmed soil fertility, which in turn had a negative impact on agricultural yield. On the other side, uncontrolled population growth, urbanization, and socioeconomic progress have boosted living standards. These generate massive amounts of municipal solid trash worldwide, particularly in India. It primarily pollutes soil and water with various pollutants such as heavy metals and other comparable things. Both of these scenarios devastate the earth's environment and increase the toxicity in the foodecosystems. Biofertilizers with pollution remediation properties are being considered as a possible solution to this persistent problem. Present thesis research aims to address this issue. Soil samples were collected from the Boragaon dumping site in Guwahati, Assam contaminated with municipal solid waste (MSW) and has a common border with the ecologically sensitive Deepor Beel area (Ramsar site No. 1207). According to the analysis, these soil samples had the least soil nutrition and the high heavy metals level. With selective media, approximately 400 Phosphate solubilizing bacteria (PSB) and 350 N fixing bacteria (NFB) were isolated from soil samples.

Following molecular characterization, the diversity of *Bacillus* sp., *Enterobacter* sp., and *Paraburkholderia fungorum* was discovered. Furthermore, the PSB were cultured in Pikovskaya (PVK) media, resulting in organic acid and enhanced acid phosphatase (ACP) activity. SM\_SS8 had the best Cd and Cu tolerance capacity among all the tested strains (up to 100 mg L<sup>-1</sup>). The growth pattern of SM\_SS8 was investigated using optical density (OD) and kinetic growth measurements. Infrared spectroscopy (IR) and X-Ray Diffraction (XRD) studies were used to examine the strain's Cd and Cu degradation capability. The optimum

concentration of Cd and Cu bio-precipitation in the SM\_SS8 cell has been studied using SEM-EDX. In Cd-treated bacterial cell cultures, flow cytometry analysis revealed that 70.92%, 46.93%, and 20.4% of viable SM\_SS8 bacterial cells were identified in 10, 50, and 100 mg L<sup>-1</sup>, respectively. The potential of biochar, biofertilizer, and their formulation to remediate HMs-contaminated soils and improve soil quality and plant production (like tomato) was also investigated through a pot experiment. The pot experiment results demonstrated that biofertilizer and biochar have a synergistic impact, resulting in improved soil nutrition and plant growth. Simultaneously, bacterial taxonomic analysis of harvested soil samples revealed that, the treated samples had higher diversity when compared to CK. The findings showed that a single biofertilizer and its formulation were best for various soil features such as physico-chemical, microbial diversity, and biochemical parameters.

**Keywords:** Bioremediation; Municipal solid waste (MSW); Phosphate solubilizing bacteria (PSB); Nitrogen Fixing Bacteria (NFB); Heavy metals (HMs).