Impact of Zinc Oxide Nanoparticles on Cellulose Degrading Actinomycetes

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Abstract

The actinomycetes are widely researched and reported as the diverse micro-machinery with incredible capabilities to synthesize and secrete the enzymes like cellulase, chitinase, lipases and many other bioactive compounds which are involved in reclamation and the fertility of soil. Cellulases produced from the actinomycetes have additional advantages over other sources such as bacteria due to their thermal and pH stability, as well as availability in diverse environmental conditions.

The enhanced use of nanoparticles (NPs) has increased concern about risk for the environment and soil because it affects microbial processes and may damage soil fertility. Microbial ecotoxicity of the NPs has gained huge attention from the researchers across the globe; however, due to unavailability of consolidated data and detailed analysis, it is difficult to reach the conclusion about the NPs induced toxicity in soil. The present thesis investigate the possible mechanism of the NPs toxicity on cellular and functional level (cellulose degradation potential).

In the study, actinomycetes with cellulose degradation potential were isolated from the soil of different locations because of the availability and adaptation of the wide range of novel species distribution in diverse soil conditions.

As the next step, ZnO NPs were synthesized using Cow dung extract and characterized by various microscopic and spectroscopic methods. The antimicrobial potential of these ZnO NPs synthesized from Cow dung extract were evaluated against different microorganisms. Compared with control, the impact of biologically synthesized ZnO NPs on seed-germination, root and shoot lengths were

also estimated. Results suggested that ZnO NPs could significantly induce the germination of mung beans and does not disturb microbial flora and fauna due to minimal *in vitro* toxicity on test microorganisms.

In the next step, the catalytic potential of ZnO NPs on cellulose degradation was investigated with the help of solid-state fermentation (SSF) of rice straw and crude cellulase was recovered as another important outcome of the study. The ZnO NPs (1 mg/gm) were supplemented in a solid-state fermentation medium with the isolated actinobacterial species *Streptomyces calvus* for cellulase production at 30 ^{0}C for 15 days. Pure culture-based studies were performed to evaluate the toxicity of cow dung based and commercial ZnO NPs on the isolated *S. calvus*.

The microcosm study was performed to observe the ecotoxicological potentials of ZnO NPs on bacterial and actinobacterial diversity of the field soil. The overall outcome of the study suggests that biologically synthesized ZnO NPs could be a safer alternative to commercial ZnO NPs for agricultural applications, minimizing toxicity to soil microorganisms while enhancing cellulose degradation in the soil.