Bacterial Nanoparticles: Biosynthesis, Optimization, Characterization and Their Application for Phytostimulatory Potential in Zea Mays L.

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ABSTRACT

Nanotechnology is the vast and splendid discipline of science and it has crossed peaks of immense development in modern era due to its number of applications in various fields. As a result, plants are deprived of essential nutrients. Nano-fertilizers provide best possible solution to overcome this problem. The present work was aimed to evaluate the synthesis of sliver nanoparticles from bacterial species i.e., *Bacillus tropicus* (S12) and *Serratia marcescense* (S4c1) and was optimized at varying conditions. Further the optimized AgNPs were characterized by using UV–Visible spectroscopy (UV–Vis), Fourier-transform infrared (FTIR), Scanning electron microscopy and Energy Dispersive X-ray analysis. Moreover the Phytostimulatory impact of these synthesized AgNPs was observed with *Zea mays* L. It was observed that the silver nanoparticles synthesized have growth promoting potential of plants and can be used for plant growth improvement in place of chemical fertilizers.

Keywords: $AgNO_3$, Biosynthesis, Nanoparticles, Phytostimulation, *Zea mays* L.

INTRODUCTION

Fertilizers are long being utilized in agricultural sector for crop maintenance but the problem with the conventional chemical fertilizers is their persistence in soil for longer period of time causing barrenness of soil (Iravani, et al. 2014). As a result, plants are deprived of essential nutrients. Nano-fertilizers provide best possible solution to overcome this problem as they are released on demand, are site specific, efficient and easily soluble. Among the nanoparticles, silver nanoparticles are widely used for commercial purposes (Awan, et al. 2021). Biosynthesis of nanoparticles from microbes is the better alternative due to broad spectrum of bioactive reducing metabolites. As most metal ions are toxic for the bacteria and therefore, bioreduction of these ions or formation of water insoluble complexes is the defense mechanism that is developed by most of the bacteria to stunned such toxicity (Sehnal, et al. 2019)

OBJECTIVES

Bacteria possess a significant aptitude to reduce heavy metal ions and they are one of finest candidates for synthesis of nanoparticles. Considering that the objectives of present study include the following:

- To synthesis the silver nanoparticles using the biological approach and their characterization using advance techniques.
- To evaluate their effect for growth promotional potential for wheat plants.
- To optimize the concentration of silver nanoparticles suitable for the plant growth potential.

MATERIAL AND METHOD

The present study was aimed to optimize the synthesis of sliver nanoparticles from bacterial isolates i.e., *Bacillus tropicus* (S12) and *Serratia marcescense* (S4c1). Which were optimized at varying temperatures, time intervals, pHs, different concentration of plants extract, different concentrations of reagents and with varying concentrations of NaCl. The optimized bacterial AgNPs were characterized by using UV–Visible spectroscopy (UV–Vis), Fourier-transform infrared (FTIR), Energy Dispersive X-ray analysis and Scanning electron microscopy. The impact of these synthesized AgNPs was then checked with *Zea mays* L. by analyzing the physical (root length, shoot length, fresh weight and No. of leaves) and biochemical (chlorophyll a, chlorophyll b, total chlorophyll and protein content) parameters with the control treatments.

RESULTS

The optimization of silver nanoparticles indicated that they possess the highest absorption peak at 420-460nm at 40oC and at pH 7 after 24 hours of incubation period. Similarly, they possess the highest absorption spectra at 2% NaCl concentration with 1:1 of the bacterial suspension and chemical reagent. The results of UV-Visible showed maximum peak at the range of 400-440nm that confirmed the synthesis of silver nanoparticles. Similarly, FTIR analysis indicated the presence of various functional groups such as for nitriles, alkanes, anhydrides, sulphate, amides and nitro compounds etc. and EDX analysis also showed strong peaks of Ag confirming the presence of biologically synthesized AgNPs. Phytostimulatory potential of these bacterial AgNPs showed improved growth of *Zea mays* L. plants suggesting their potential use as nano fertilizers.

CONCLUSION

In the nutshell, by the various treatments of AgNPs to plants in different concentrations it is concluded that exposure to the definite range of concentrations of AgNPs can improve plant growth but the application in higher concentrations of silver nanoparticles could affect negatively. Moreover, other characteristics of the nanoparticles such as size, stabilizing substance and reducing agent could also impact on nanoparticle toxicity. Nanoparticles are effective for plant growth only in the minor quantities and can be used to enhance the crop production in the replacement to non-biodegradable, long lasting and hazardous chemical fertilizers.

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