BIOSYNTHESIS OF COPPER NANOPARTICLES AND ITS EFFECT ON SEED GERMINATION

Janvi Singh and Dipjyoti Chakraborty
Department of Bioscience and Biotechnology,
Banasthali Vidyapith, Rajasthan, India
janvi.singh049@gmail.com

Introduction

It is well known that, each of the nutrient elements plays a major role in growth and development of the plants and when present in deficient quantities can reduce growth and yields. In plants, copper (Cu) is a micronutrient necessary for the protein components of enzymes[1]. So, nanoscience can be used as a potential source in the field of agriculture for the development of processes and products that are hardly possible to develop through conventional methods. Biological method using Plant Growth Promoting Rhizobacter (PGPR) is preferred for the synthesis of copper nanoparticles (CuNP).


a

Methodology

Nanoparticles were synthesized by biological method. The bacterial cells were centrifuged at 10000 rpm for 10min and supernatant were mixed with 1mM Copper Sulfate solution and kept for incubation at 28°C±2°C for 24h-48h in a rotatory shaker at 120-150rpm. The synthesized CuNP were characterized using UV –Visible spectroscopy ranges 400-800nm and FTIR [2and 3]

In order to check the effect of CuNP on seed germination of chickpea and mungbean, various concentrations 0.2mg/L, 0.4mg/L, 0.6mg/L, 0.8mg/L, 1.0mg/L were taken. Total 10 seeds of chickpea and 14 seeds of mungbean were sterilized and soaked for 24h in CuNP solution and distilled water was taken for control and sown in petridishes on sheets of filter paper moistened with distilled water. Depending on water holding capacity 2ml distilled water was added to each petridishes and growth measurements were taken after 5 days of germination [1]

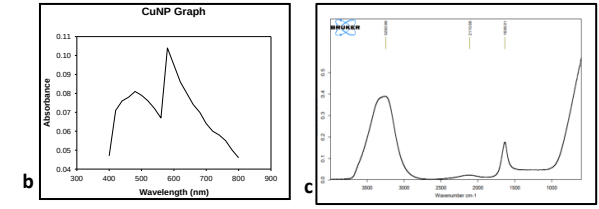

Figure 1: Characterisation of synthesized CuNP a)physical appearance, b) UV-visible absorption and c)FTIR

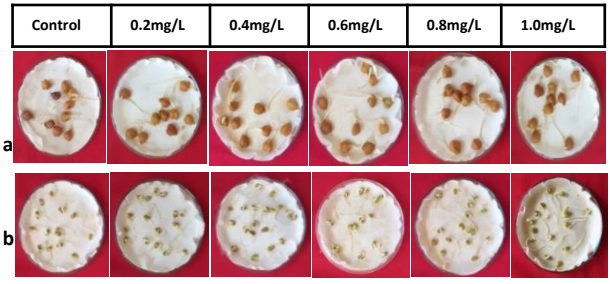

Figure 2: Seed germination a) chickpea and b) mungbean at various concentration of CuNP by petriplate method

Results

1.Biosynthesis of CuNP: The synthesis of nanoparticle was initially confirmed by change in color (Figure 1a) i.e. light green to dark green and later confirmed by UV- visible analysis. The spectrum (Figure 1b) showed the absorbance peak at 560 nm due to formation of surface Plasmon resonance and (Figure 1c) FTIR result showing presence of carboxylic group.

2. Effect of CuNP on seed germination: After application of CuNP at various concentration (Figure 2a & 2b), the maximum growth was obtained at 0.6mg/L in both chickpea and mungbean followed by 0.4mg/L (Table 1) while germination percentage was 100% in all concentration including control.

Table 1: Measurement of radicle length in chickpea and mungbean (Results are mean ± standard deviation; significance value according to p<0.05 following LSD and ANOVA).

S.No.	Concentration (mg/L)	Radicle length (cm)	
		Chickpea	Mungbean
1.	Control	3.05 ± 0.269^{1}	4.35 ± 0.165^{1}
2.	0.2	$3.73\pm0.204^{2,3}$	4.48 ± 0.204^{1}
3.	0.4	$4.23\pm0.326^{4,5}$	5.43 ± 0.147^{3}
4.	0.6	4.55 ± 0.165^{5}	5.88 ± 0.286^{4}
5.	0.8	$4.08\pm0.147^{3,4}$	$5.20\pm0.254^{2,3}$
6.	1.0	3.50 ± 0.122^{2}	4.98 ± 0.192^{2}

Conclusion

In this work, CuNP were synthesized successfully using PGPR by biological method to enhance the absorption of copper by legume plant and we found that 0.6mg/L is the optimal concentration of CuNP for the seed germination and plant growth of chickpea and mungbean. As Cu can disrupt plant growth and development by interfering with key physiological processes in either its deficiency or excess.

References

1. Ibrahim AS, Ali GA, Hassanein A, Attia AM, Marzouk ER. Toxicity and uptake of CuO nanoparticles: evaluation of an emerging nanofertilizer on wheat (Triticum aestivum L.) plant. Sustainability. 2022 Apr 19;14(9):4914.
2. Yadav A, Theivasanthi T, Paul PK, Upadhyay KC. Extracellular biosynthesis of silver nanoparticles from plant growth promoting rhizobacteria Pseudomonas sp. arXiv preprint arXiv:1511.03130. 2015 Nov 6.
3. Tiwari M, Jain P, Hariharapura RC, Narayanan K, Bhat U, Udupa N, Rao JV. Biosynthesis of copper nanoparticles using copper-resistant Bacillus cereus, a soil isolate. Process Biochemistry. 2016 Oct 1;51(10):1348-56.