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RESEARCH ARTICLE

EFFECT OF GOLD NANOPARTICLES ON GERMINATION STATUS OF CEREALS

***Nishat U. Shaikh and Ashok M. Chavan**

Department of Botany, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

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ABSTRACT

Nanotechnology is a branch of biology which deals with study of nano-materials, nanoparticles and its applications. Nowadays, nanotechnology occupies a large area due to its importance in the entire field. Pharmacological industries and textile industries were solely dependent on the use of nanoparticles. Biological method is a good alternative source for the production of nanoparticles as compare to physical method and chemical methods. Microorganisms provide good alternative for the same due to its large availability and cheapest investment. Fungi have capacity to multiply rapidly, so it can be used for the production of nanoparticles. In the present investigation different species of *Penicillium* was used for the production of gold nanoparticles. The color of cell free filtrate turned into different shades of purple color which indicates the synthesis of gold nanoparticles. Effect of these synthesized gold nanoparticles was tested against Wheat, Jowar and Bajra; which shows significant results in germination status of these cereals.

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INTRODUCTION

Nanotechnology is emerging as one of the most important and revolutionizing area in research field. Nanoparticles are produced by various methods like physical, chemical, mechanical and biological. Biological methods of reduction of metal ions using plants or microorganisms are often preferred because they are clean, nontoxic, safe, biocompatible and environmentally acceptable. Nanotechnology mainly focuses on the development of syntheticas well as natural systems for the production of structures and materials at nanoscale (Absar *et al*., 2005). Nanoparticles can be synthesized from physical and chemical methods. The simplest method for the production of nanoparticles is the reduction of their respectivesalts (Rashmi and Preeti, 2009). Other strategies includelithography, sonochemical processing, cavitation processing, micro-emulsion processing, UV irradiation and high energy ball-milling. However, these methods are expensive, toxic and involve the use of harmful chemicals apart from other complexities like low stability of the produced nanoparticles and aggregation of the particles (Raffi, 2007). Hence, in order to produce the nanoparticles by clean, non-toxic, safe, biocompatible and environmentally acceptable methods, many biological systems have been used to produce the nanoparticles both intracellularly and extracellularly (Boisselier and Astruc, 2009).

Corresponding author:* **Nishat U. Shaikh
Department of Botany, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

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Some well-known examples include the use of bacteria, fungi and plants for the production of nanoparticles. Fungi are often used in the production of metal nanoparticles. Since fungi have several advantages over bacteria, they are often preferred. Some of the advantages of fungal sources for the production of metal nanoparticles include high tolerance towards metals, high wall-binding capacity, can be easily scaled up, easy to culture on a large scale and ability to secrete large amount of enzymes. Among the many possible bioresources, biologically active products from fungi and yeast represent excellent scaffolds for this purpose. Since fungi and yeast are very effective secretors of extracellular enzymes and number of species grow fast and therefore culturing and keeping them in the laboratory is very simple(Mishra *et al*, 2011). They are able to produce metal nanoparticles and nanostructure via reducing enzyme extracellularly (Muhsin *et al*, 2014). Not only the harvesting of extracellular synthesized nanoparticles from fungi is easy and inexpensive (Fayaz *et al*, 2010) they can also be manipulated by controlling the pH, temperature, substrate concentration (metal ions), and reaction time (Satishkumar *et al*, 2010). In the present study emphasis was given on the biosynthesis of gold nanoparticles with the help of *Penicillium* sp. and their impact on seed germination of cereals (Wheat, Jowar and Bajra).

MATERIALS AND METHOD

Isolation of *Penicillium* species: *Penicillium* species was isolated from soil, fruits and vegetables; and pure cultures were

maintained on potato dextrose agar (PDA) medium at 27^0C. The isolated fungi were identified by using morphological characterization with the help of standard manuals.

Production of biomass: *Penicilliumbilaiae, P.chrysogenum, P. citranum, P.digitatum, P. expansum, P.funiculosum, P.islandicum, P. notatum, P. rubrum*and *P. verruculosum*was grown in glucose nitrate broth medium (GNB) for biomass production. The individual flasks were incubated with spore suspension of fungi on shaker at 28^0C for 3 days. Harvesting of biomass was carried out with the help of what man filter paper no.1 and washed with distilled water to remove any in gradient of the medium. Then this biomass were transferred in separate flask containing 100ml of double distilled water and incubated for 2 days. This biomass was again filtered through what man filter paper no.1 and cell free filtrate was kept for the further experiments.

Biosynthesis of Gold nanoparticles: Gold nanoparticles was synthesized by using 1mM solution of $HAuCl_4$ and cell free filtrate in 1:1 propertion i.e. 20ml of 1mM solution of HAuCl4 and 20ml cell free filtrate in 250 ml Erlenmeyer flask and incubated at 28^0C for 24hrs in dark. $HAuCl_4$ solution was used as control.

Characterization of Gold nanoparticles: Visual analysis and UV- visible spectrophotometer were used for qualitative testing for gold nanoparticles. 1ml sample was taken and absorbance were recorded at 300-650nm.

Seed germination assay on cereals: Fresh seeds of cereals (Wheat, Jowar and Bajra) were taken in separate petriplates. Seeds were soaked in gold nanoparticles synthesized by *Penicillium* species separately for 1 hr. Control seeds were soaked in distilled water. All the treated and control seeds were transferred in humidity chamber for germination and germination was recorded after 2 days. Effect on root and shoot length was also count after 5 days.

RESULTS AND DISCUSSION

Visual analysis: It is the preliminary test for the biosynthesis of gold nanoparticles from cell free filtrate of different *Penicillium* species. After the adding of chloroauric acid into the cell free filtrate, the color of the solutions gets changed into different shades of purple color. Which clearly indicate the synthesis of gold nanoparticles.

UV- Spectrophotometer analysis: Cell free filtrate and biosynthesized nanoparticles were monitored on UV-spectrophotometer. No peak formation was recorded in cell free filtrate of all the selected species of *Penicillium.* While in the solution of cell free filtrate and chloroauric acid a strong peak was formed at 450 nm; which indicates the synthesis of gold nanoparticles.

Seed germination assay: Seed germination assay was carried out by testing the cereals seeds against biosynthesized gold nanoparticles. From the table 1 it was clear that seed germination was increased in gold nanoparticles treated seeds of Wheat, Jowar and Bajra as compare to control seeds. Maximum seed germination was recorded in Jowar seeds followed by Wheat and Bajra by the action of these gold nanoparticles.

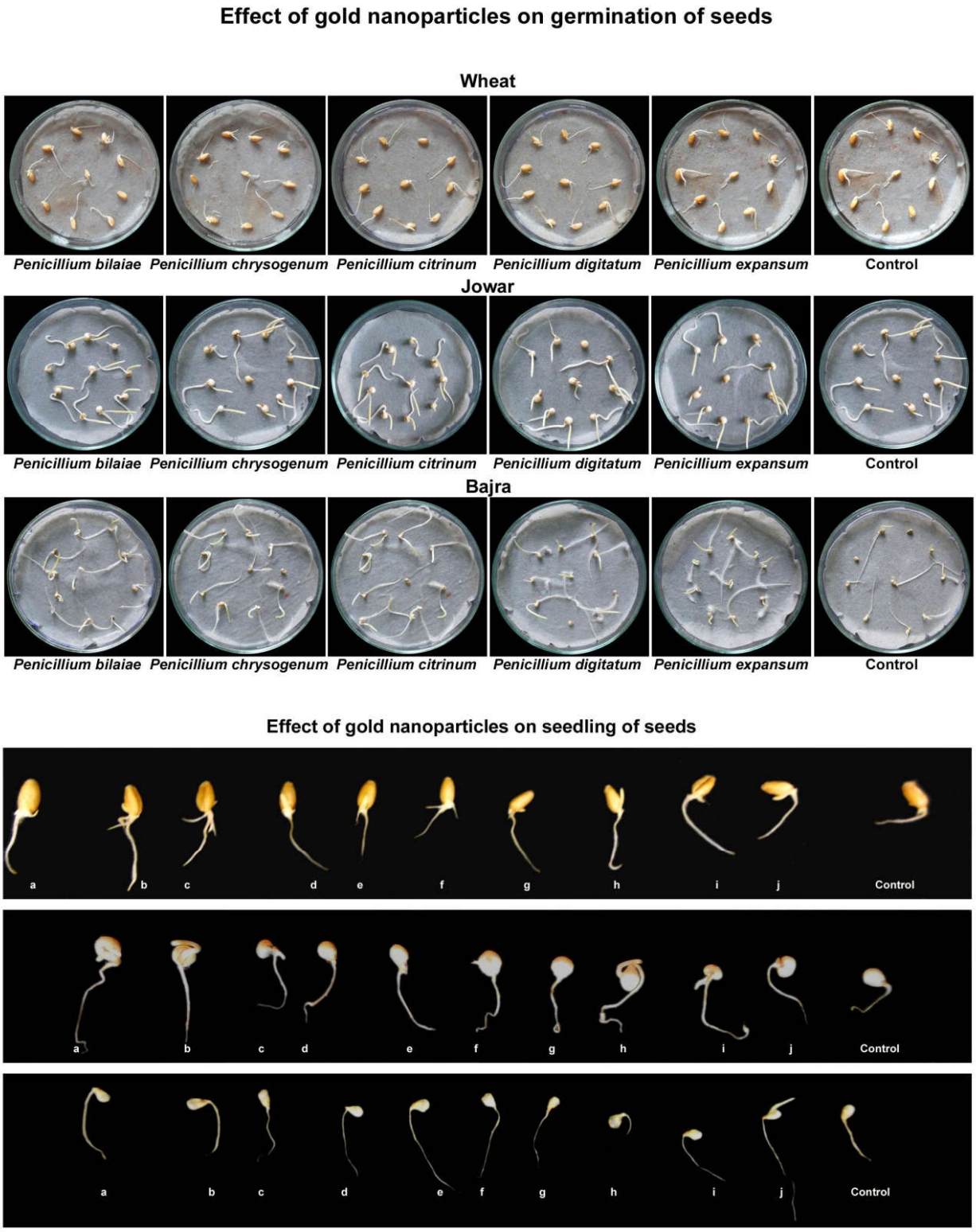
Effect of gold nanoparticles on seedlings: Gold nanoparticles also showed significant results on seedlings of Wheat, Jowar and Bajra.

Effect of Gold nanoparticles on Germination status of different cereal

Sr.No.	Name of fungi	Different Cereal Seed		
		Jowar	Bajra	Wheat
1)	*Penicilliumbilaiae*	10	10	09
2)	*Penicilliumchrysogenum*	09	09	10
3)	*Penicilliumcitranum*	10	09	09
4)	*Penicilliumdigitatum*	09	09	10
5)	*Penicilliumexpansum*	09	10	10
6)	*Penicilliumfuniculosum*	09	10	09
7)	*Penicilliumislandicum*	10	08	09
8)	*Penicilliumnotatum*	10	09	10
9)	*Penicilliumrubrum*	10	10	10
10)	*Penicilliumverruculosum*	09	09	10
c)	*Control*	09	08	09

Effect of Gold nanoparticles on root & shoot length of different cereals

Sr.No.	Name of fungi	Different Cereals (In cm)					
		Jowar		Bajra		Wheat	
		Root	Shoot	Root	Shoot	Root	Shoot
1)	*Penicilliumbilaiae*	5.2	2.2	5.1	2.0	5.0	1.8
2)	*Penicilliumchrysogenum*	5.4	2.3	5.3	2.3	5.4	1.9
3)	*Penicilliumcitranum*	4.9	2.0	5.1	2.0	5.3	1.9
4)	*Penicilliumdigitatum*	5.0	2.2	5.0	2.0	5.0	1.6
5)	*Penicilliumexpansum*	5.2	2.1	4.9	1.9	4.9	1.7
6)	*Penicilliumfuniculosum*	4.8	1.9	5.2	2.1	4.8	1.9
7)	*Penicilliumislandicum*	5.1	2.1	5.3	2.2	5.1	2.0
8)	*Penicilliumnotatum*	5.5	2.4	4.8	1.9	5.0	1.7
9)	*Penicilliumrubrum*	4.9	2.0	5.0	2.1	4.8	2.0
10)	*Penicilliumverruculosum*	4.8	2.0	5.0	1.8	4.9	1.7
c)	*Control*	4.8	2.1	4.9	1.8	4.8	1.5



a. ***Penicillium bilaiae,*** **b.** ***Penicillium chrysogenum,*** **c.** ***Penicillium citrinum,*** **d.** ***Penicillium digitatum,*** **e.** ***Penicillium expansum***
f. ***Penicillium funiculosum,*** **g.** ***Penicillium islandicum,*** **h.** ***Penicillium notatum,*** **i.** ***Penicillium rubrum,*** **j.** ***Penicillium verreculosum***

In treated seeds root and shoot length of seedlings was increased as compare to control from table 2. Maximum root length was recorded in Jowar seeds by the action of gold nanoparticles of *Penicilliumnotatum*(5.5 cm).

Conclusion

The present study conclude that the biosynthesis of gold nanoparticles from different *Penicillium* species by using 1mM chloroauric acid solution. The synthesized gold nanoparticles shows maximum absorption peak at 450nm and these gold nanoparticles helped to increase the seed germination in Wheat, Jowar and Bajra.

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