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Antimicrobial activity of silver nanoparticles synthesized from the selected pteridophytes

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Abstract

The aim of the present paper was to synthesis of silver nanoparticle derived from selected pteridophytes and their nanoparticles were investigated by antibacterial activity by disk diffusion method. The results of antibacterial potential of selected pteridophyte species were synthesized by silver nanoparticles active against *B. subtilis, E. coli, K. pneumoniae, Proteus valgaris, P. aeruginosa, Salmonella typhi* and *S. aureus*. The maximum activity of nanoparticles of *C. interruptus* active against *P. aeruginosa* and *K. pneumoniae*. The conclusion of the present study was synthesis of silver nanoparticles of *C. interruptus* and *A. aureum* were active against all tested bacteria.

Keywords: Pteridophytes, nanoparticles, antibacterial activity, bacteria

1. INTRODUCTION

The pteridophytes are non-vascular flowering plants and spore-bearing plants including ferns and fern-allies. The origin of pteridophytes species about 250 million years ago they were the dominant part of earth's vegetation, but they were largely replaced by the seed-bearing plants. The species of the pteridophytes were grow luxuriantly in moist tropical and temperate forests and their occurrence in different eco-geographically threatened regions from sea level to the highest mountains are of much interest [1]. Pteridophytes comprises over 300 genera and about 12,000 species and in India by almost 1000 species, of which 47 are endemic to India [2] and some of these species are placed under RET category. Traditionally, plant extracts of pteridophytes are used as antibacterial agents. The evolutionary success of pteridophytes for more than 350 million years may be due to this antibacterial activity. Silver nanoparticles synthesized in several pteridophyte species were previously reported [4]. To the best of our knowledge, use of pteridophytes in nanoparticles synthesis has few species are studied [3]. Hence, in the present study aim to an antibacterial potential of nanoparticles synthesized from the selected species of pteridophyte performed against Gram-positive and Gram-negative human pathogens using disc diffusion method.

2. MATERIALS AND METHODS

2.1 Plant Materials

The plant materials of *Cyclosorus interruptus, Diplazium esculentum, Ceratopteris thalictroides*, and *Acrostichum aureum* were collected from Southern Western Ghats, Tirunelveli District, Tamilnadu.

2.2 Preparation of aqueous extract

10gm leaf materials of *Cyclosorus interruptus, Diplazium esculentum, Ceratopteris thalictroides*, and *Acrostichum aureum* were air dried and powdered. These leaves powdered materials were then mixed with 100 ml distilled water at room temperature for 12h. The extracts were

collected and supernatant solution was recovered through centrifugation and passed through nylon membrane filter paper to remove fine particles. The aqueous extracts of plant materials thus obtained and dialyzed to remove the inorganic ions. Ion free aqueous extracts were then dried in the freeze drier, and approximately 80mg of residue was obtained. An appropriate quantity of crude was redissolved in distilled water to prepare 1000 ppm stock solution of aqueous extract.

2.3 Synthesis of AgNPs

Working solution for the biosynthesis of AgNPs consists of 10 ppm aqueous extract and silver nitrate (AR grade) ranging between 0.001 and 0.01 mol/L. In the reaction media aqueous extract function both as reducing and capping agent for the syntheses of AgNPs. A uniform temperature of 75°C was maintained throughout the experiment, using a hot air oven. Reduction of Ag ions to Ag nanoparticles was inferred from the color change, colorless to pale yellow [5-6].

2.4 Investigation of Antibacterial potential

2.4.1 Pathogens

The selected human pathogen such as such *as Bacillus subtilis, Staphylococcus aureus, Proteus species, Klebsiella pneumoniae, Pseudomonas aeruginosa, Salmonella typhi* and *Escherichia coli* were selected for the screening. Antibacterial potential of AgNPs was investigated using disc diffusion assay. Each disc was uniformly dispersed with AgNPs to obtain a particle concentration of 1 nmol/mL. Silver-free aqueous extracts of *Cyclosorus interruptus, Diplazium esculentum, Ceratopteris thalictroides,* and *Acrostichum aureum* were used as control. Average of triplicate analyses was used to evaluate the potential of AgNPs to suppress the viability of pathogens [5].

3. RESULTS AND DISCUSSION

The results of antibacterial potential of selected pteridophyte species are synthesized nanoparticles in an active against selected human pathogens represented in the table-1. Nanoparticles of *C. interruptus* extract was tested against *B. subtilis, E. coli, K. pneumoniae, Proteus valgaris, P. aeruginosa, Salmonella typhi* and *S. aureus*. The maximum activity of nanoparticles of *C. interruptus* active against *P. aeruginosa* and *K. pneumoniae*. Previously studies, aqueous and acetone extracts of epidermal glands of the ferns, *Christella parasitica* and *Cyclosorus interruptus* were active against *Salmonella typhii* (7-8). *Diplazium esculentum* extract was derived nanoparticle was active against minimum level of all tested bacteria seen in the table-1. Earlier report, *Diplazium esculentum* has been reported that antitumor and anticancer activities [9]. *Ceratopteris thalictroides* was derived silver nanoparticle was medium level active against *P. aeruginosa* and other bacteria was active against minimum level activity. The antibacterial potential of mangrove fern *Acrostichum aureum* Linn was moderately active against all the tested bacteria seen in the table-1. *Dryopteris filix*-mas was moderately active against all tested bacteria seen in the table-1. Earlier studies antibacterial potential of *D. filix*-mas was reported [10]. Previous studies, antibacterial potential of AgNPs synthesized from the aqueous extracts of *A. raddianum, A. aureum*, and *C. dentata* against *S. aureus, Proteus* sp., *K. pneumoniae, P. aeruginosa*, and *E. coli* [3].

Table 1: Antibacterial activity of biosynthesized AgNPs of selected pteridophytes species against Gram-negative and Gram-positive bacteria

Sl.No	Pathogen Name	Zone of Inhibition (cm)				
		Cyclosorus interruptus	*Diplazium esculentum*	*Ceratopteris thalictroides*	*Acrostichum aureum*	*Dryopteris filix-mas*
1.	*Bacillus subtilis*	12	7	8	11	7
2.	*E. coli*	13	6	6	15	9
3.	*K. pneumoniae*	16	7	7	11	7
4.	*Proteus valgaris*	13	8	9	16	11
5.	*P. aeruginosa*	21	7	11	11	8
6.	*Salmonella typhi*	14	8	7	12	9
7.	*S. aureus*	15	11	6	16	11

Minimum activity (6-10 mm); Medium activity (11-15 mm); Maximum activity 16-20mm)

Nanoparticles of selected pteridophytes were observed by dark blue to dark red was observed on addition of plant extract to 5 *mM* tetrachloroauric acid solution indicating AuNPs synthesis. UV-Vis spectroscopy of this solution confirmed the synthesis of AuNPs, as revealed by a characteristic absorption peak at 530 nm [11]. On the other hand, a characteristic brick red color was formed on addition of 9 mM silver nitrate solution to the plant extract, indicating synthesis of AgNPs, which was confirmed by an absorption peak at 420 nm [12]. Similarly, pteridophyte species of *A. philippense* L. is known to contain variety of active phytochemicals like carbohydrates, glycosides, alkaloids, tannins, flavonoids, terpenoids, and saponins. These phytochemicals are responsible for making the extract highly oxidant [13] and

thus might play a role in bioreduction of silver nanoparticles. Antioxidant potential and medicinal value of *Adiantum philippense* L. fascinated us to utilize it for biosynthesis of gold and silver nanoparticles [14]. Earlier study, aqueous extract of *A. philippense* L. fronds for the green synthesis of AuNPs and AgNPs [14]. Exploitation of synthesized capped nanoparticles would enable us to know the nature of capping agent and utilize them for medicinal and biomedical applications [14]. The conclusion of the present study observed that aqueous extract of *C. interruptus*, *D. esculentum, C. thalictroides* were an effective precursor for the eco-friendly synthesis of AgNPs, for evolving the antibacterial combination to suppress human pathogens. Further studies on aqueous extracts of *C. interruptus*, *D. esculentum*, and *C. thalictroides* will be characterized by using HRTEM study the morphology, size, and distribution of nanoparticles.

4. ACKNOLWDGEMENT

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