

Green synthesis and antimicrobial studies of silver nanoparticles from some *ex-situ* conserved Bryophytes in coastal sites of Raigad district of Maharashtra, India

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Abstract

This research will use aqueous extracts of *Targionia indica* Kash., *Cyathodium tuberosum* Kash., and *Anthoceros erectus* Kash., to synthesize and classify silver nanoparticles. These bryophytes were grown *ex-situ* in the lab and further research was conducted. The current study focuses on the green synthesis of silver nanoparticles and their antimicrobial properties. In the Raigad district, bryophytes were collected from the Revdanda and Kashid coastal site vegetation. The appearance of a reddish brown colour shift suggests the development of AgNps. UV-Vis was used to classify these AgNps. The green synthesis extracts of valued bryophyte species display antimicrobial activity, i.e. zone of inhibition against bacterial strains such as *E. coli*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus*, as well as fungal strains such as *Rhizopus* spp. and *Alternaria* spp.

Keywords: bryophytes, AgNps, *Ex-situ*, UV-Vis, antimicrobial activity

Introduction

Bryophytes are primitive, nonvascular land plants with a basic thalloid plant body organization. The advanced community of bryophytes mosses held a special role between lower cryptogams and vascular cryptogams. Bryophytes are non-vascular land plants with a cosmopolitan nature and the second largest primitive group. According to Crum (2001) [12], there are about 20,000 to 25,000 species worldwide. 1980 (Barbara & Crandall Stotler) Sathish *et al.* (2013) [29] reported 482 genera and 2486 species of bryophytes in India. There are 128 species of mosses in Maharashtra's Western Ghats, belonging to 11 orders, 26 families, and 59 genera Magdum *et al.* (2017) [25]. According to Vanderpoorten and Engels, bryophytes have many applications such as pollution indicator, ornamental purpose, drug extraction, natural pesticides, fungicides, pharmaceutical industry, horticulture, fuel, antibiotic activities, and antimicrobial activities (2003).

Nanotechnology is the most promising field in nanoscience, and it is a critical factor in the advancement of new technologies in the twenty-first century. Nanotechnology is concerned with the production and application of nanomaterials for the desired object. According to Parashar *et al.* (2009) [43], there are numerous methods used to produce nanoparticle synthesis, including physical, chemical, biological, microwave assisted radiation assisted, electrochemical, and non-chemical methods.

In comparison to other approaches, the biological approach is more environmentally friendly and does not contain any toxic chemicals. The green synthesis approach is superior to the chemical and physical methods (Kowshik *et al.*, 2003) [19, 27]. Silver, gold, platinum, zinc, and copper were used in the synthesis of metal nanoparticles (Caroling *et al.*, 2013) [15]. Ashton and Callaghan (2009) [14] *Ex-situ* conservation basically translates to "off-site" conservation. It is the method of bringing an endangered species to life. *Ex-situ*

material is a Set of experimental methods that can be evaluated both in the lab and in the field. *Ex-situ* conservation of bryophytes includes many steps that are all equally important: material selection, propagation, storage (including cryopreservation), and reintroduction.

The current research is being conducted to investigate the antibacterial activity of silver nanoparticles synthesized from bryophytes *Targionia indica* Kash, *Cyathodium tuberosum* Kash, and *Anthoceros erectus* Kash. The study's aim is to evaluate antibacterial activity and establish the zone of inhibition on a specific bacterial strain. The antibacterial activity of the extract is calculated using the agar disc diffusion process. The antibacterial activity of bryophyte extract was tested against three bacteria: *E. coli*, *Pseudomonas aeruginosa* and *Staphylococcus aureus*. The antifungal activity of silver nanoparticles synthesized from bryophyte extracts on some fungal strains included *Rhizopus* spp., *Alternaria* spp. Biosynthesis is a novel method of producing nanoparticles from biological sources. It is gaining popularity due to its low-cost, environmentally sustainable, and large-scale production capabilities. Nanomaterial's are the atomic and molecular building blocks of matter (0.2 nm). Nanoparticles are a form of nanomaterial that can be amorphous or crystalline, and their surfaces can serve as carriers for liquid droplets or gases (Buzea *et al.*, 2007). Since ancient times, nanoparticles have been used in pottery and medicine. Since the last decade, the most thoroughly researched nanoparticles have been those made of noble metals such as silver, gold, and platinum (Duran *et al.*, 2005; Ankamwar, 2010; Deng *et al.*, 2009) [30, 5, 34].

Materials and Methods

Collection and extraction of plant material

The plant material was collected from Revdanda and Kashid beach nearby costal vegetation in Raigad District of