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Efficient synthesis of silver nanoparticles from *Prosopis juliflora* leaf extract and its antimicrobial activity using sewage

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HIGHLIGHTS

- The silver nanoparticles will be synthesis within 5 min and it will settled down after 10 min of mixture.
- The synthesized silver nanoparticle has good antibacterial activity and it is polygonal in shape.
- The plant where used for silver nanoparticles is a weed plant.

GRAPHICAL ABSTRACT

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ABSTRACT

In this paper, aqueous extract of fresh leaves of *Prosopis juliflora* was used for the synthesis of silver (Ag) nanoparticles. UV–Vis spectroscopy studies were carried out to asses silver nanoparticles formation within 5 min, scanning electron microscopic was used to characterize shape of the Ag nanoparticles, X-ray diffraction analysis confirms the nanoparticles as crystalline silver and facecentered cubic type and Fourier transform infra-red assed that shows biomolecule compounds which are responsible for reduction and capping material of silver nanoparticles. The anti microbial activity of silver nanoparticle was performed using sewage. The approach of plant-mediated synthesis appears to be cost efficient, eco-friendly and easy methods.

Introduction

Nanotechnology is an emerging field in the area of interdisciplinary research, especially in biotechnology. The synthesis of silver nanomaterials or nanoparticles extensively studied by using chemical and physical methods, but the development of reliable technology to produce nanoparticles is an important aspect of nanotechnology. Biological synthesis process provides a wide range of environmentally acceptable methodology, low cost production and minimum time required [1].

Numerous methodologies are originated, to synthesize noble metal nanoparticles of particular shape and size depending on specific requirements, because metallic nanoparticles properties dependent on size and shape, that are interest for applications ranging from catalysts and sensing to optics, antibacterial activity and data storage [2–6]. Nanoparticles of noble metals are even used for the purification of water which is one of the essential enablers of life on earth [7]. In particular, Ag nanoparticles are used in diagnostic biomedical optical imaging [8].

Biosynthesis of nanoparticles as an emerging highlight of the intersection of nanotechnology and biotechnology has received

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increased attention due to a growing need to develop environmentally benign technologies in material synthesis [9]. Since eco-friendly process for nanoparticle synthesis focus turned towards 'Green' chemistry and bioprocesses [10].

Silver nanoparticles are definitely the most widely used nanomaterials among all, which are used in antimicrobial agents, textile industries, water treatment, sunscreen lotions etc. [11,12]. Due to the outbreak of the infectious diseases caused by different pathogenic bacteria and the development of antibiotic resistance the pharmaceutical companies and the researchers are searching for new antibacterial agents [11]. Regarding that silver is a nontoxic, safe inorganic antibacterial agent used for centuries and is capable of killing about 650 types of diseases causing microorganisms [13]. While various hypothesis exist regarding the mechanism of antimicrobial activity of silver nanoparticles, one of the principal mechanisms is incorporation of silver nanoparticles in the cell membrane, resulting in leakage of intracellular substances which eventually causes cell death [14,15].

Many reports have been published in the literature on the biosynthesis of silver nanoparticles using several plant extracts, particularly geranium leaves (*P. graveolens*) [16], Neem leaf broth (*Azadirachta indica*) [17], *Hibiscus rosa sinensis* (Philip 2010), lemon (*Citrus limon* [18].

Prosopis juliflora is locally available, belonging to the family fabaceae and has not been explored as pharmaceutical use. *P. juliflora* trees survive in dry climates because their root system can often extend more than 100 feet, so that they can outlast everything else and also it can survive along the coastal area. Since the present paper describes for the first time, *P. juliflora* leaf-mediated biosynthesis of silver nanoparticles and its antibacterial activity.

Materials and methods

Preparation of P. juliflora leaf broth

P. juliflora leaves were collected from the front of CAS in marine biology, Annamalai University, Tamilnadu, India. The *P. juliflora* fresh leaf extract used for the reduction of Ag+ ions to Ag°. The leaves extracts was prepared by taking 20 g of thoroughly washed finely cut leaves in 500 ml Erlenmeyer flask along with 100 ml of distilled water and then boiling the mixture about 15 min. Further, the extract was filtered with Whatman No. 1 filter paper.

Synthesis of silver nanoparticles

In a typical experiment, the leaf extract was mixed with 0.01 M AgNO3 aqueous solution at different ratio 1:1, 1:2, 1:3, 1:4, 1:5, 1:6, 1:6, 1:7, 1:8, 1:9, and 1:10. The bioreduced aqueous component

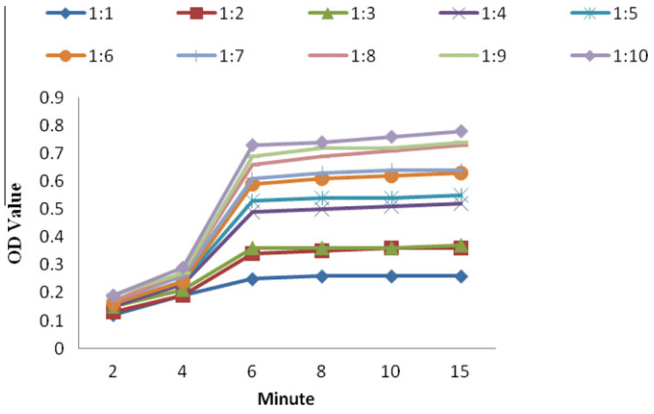

Fig. 2. OD of UV–Vis spectra of silver nanoparticles synthesis at different ratio and time.

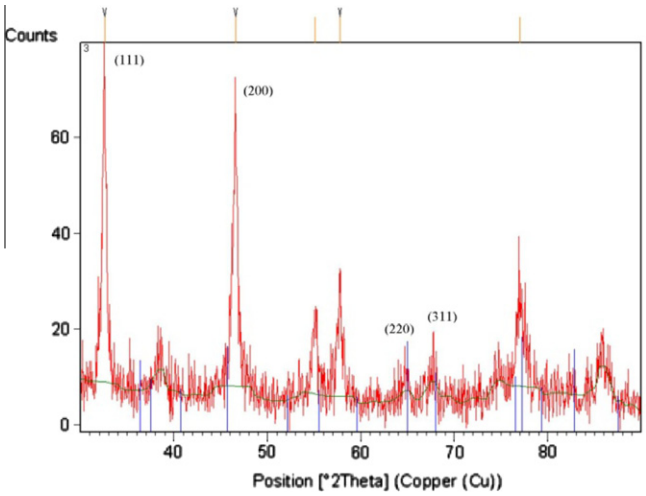

Fig. 3. XRD pattern of silver nanoparticles.

1 ml was used to measuring UV–Vis spectra of the solution. The particle suspension was diluted 10 times with distilled water to avoid the errors due to high optical density of the solution.

Characterization of silver nanoparticles

Synthesized silver nanoparticles was confirmed by sampling the aqueous component of different time intervals and the absorption maxima was noted by UV–Vis spectrophotometer wavelength at

Fig. 1. Silver nitrate solution (A), plant extracts (B), synthesized silver nanoparticle after 5 min (C), silver nanoparticles settle down after 10 min.