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Phytogenic Nanoparticles to Combat Multi Drug Resistant Pathogens and Photocatalytic Degradation of Dyes

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Abstract
The present study reports the synthesis of silver nanoparticles using *Sanguisorba officinalis*. The synthesized nanoparticles were characterized using UV-visible spectrophotometry which displayed maximum absorbance at 427 nm. The FTIR analysis predicted the presence of hydroxyl, amine methyl, and carboxyl groups indicating the role of phyto-components to mediate the synthesis. The XRD studies revealed the crystalline nature of nanoparticles with Bragg's intensities at 2 theta angle. The morphological characteristics were studied with TEM analysis which displayed polydispersity of nanoparticles with average size between 10 and 50 nm. The antibacterial efficacy of nanoparticles was determined against multi-drug-resistant pathogens which resulted in highest activity against *Ps. aeruginosa* strain 215 and MRSA with 18 mm zone of inhibition. The minimal inhibitory concentration ranged between 250 and 500 μg/ml to suppress the growth test pathogens. Photocatalytic degradation of safranin and crystal violet was studied using nanoparticles which resulted in rapid decolorization within 180 min of incubation time. Overall, the results obtained in the present investigation revealed the multi-applicative properties of nanoparticles to combat drug-resistant pathogens and catalytic activity against hazardous dyes.

Keywords Plant mediated · Silver nanoparticles · Antibacterial activity · Multi-drug resistance · Dye degradation

1 Introduction

The ongoing efforts to resolve antimicrobial resistance have expanded in recent times due to the growing concerns in both healthcare and environmental sectors [1]. The most widely used antibiotics have become ineffective to combat drug-resistant pathogens [2]. According to the recent survey reports of WHO, the drug-resistant infections have magnified and led to the increase in the mortality and morbidity rates which are expected to increase more by 2050 [3]. Simultaneously, environmental pollution has created huge impacts on all forms of lives. Especially the industrial waste which is occupying the natural habitats has direct influence on the terrestrial and aquatic lives [4]. These pollutants are reported to be carcinogenic even at trace levels, and one such pollutant includes dyes [5]. These dyes are majorly used in industrial sectors such as textile industries, paper industries, and paint industries [5]. To curb the current situation, scientific communities are engaged in developing the best suited strategies by implementing the latest technological knowledge. One such area includes the use of nanotechnology, which is considered to be the rapidly growing area of science in the current scenario. The principles of nanotechnology have uplifted various existing systems in different scientific zones such as compact fuel cells, storage capacity, robotics, pharmaceuticals, textile industries, drug delivery, bio-sensing, semiconductors, environmental monitoring, and antimicrobial agents [6]. The technological aspects of nanotechnology mainly rely on the development of type of nanoparticles. Lately, there has been a paradigm of synthesizing efficient nanoparticles with minimal side effects, cost effective, and environmental risks [7]. Mostly, the conventional routes to synthesize nanoparticles are often associated with the use of toxic elements or require high-end technologies and instrumentation [8]. Further,

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