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Research Article

Antioxidant potential of biogenically synthesized silver nanoparticles using *Prunus armenica* fruit extract

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Abstract

Nanotechnology has been an interdisciplinary science that combines physics, chemistry, engineering, biology. Silver nanoparticles (AgNPs) work as the next generation, anti-economic agent, having good pharmaceutical potential. In this work synthesis of silver nanoparticle was carried out using Prunus armeniaca fruit extract, which was used as a reducing and stabilizing agents. Spectral analysis of AgNPs were done by UV-Visible spectroscopy and Fourier Transform Infrared Spectroscopy (FTIR). While, for morphological analysis Scanning Electron Microscopic (SEM) analysis, Energy Dispersive spectroscopy analysis (EDS) and X-Ray Diffraction (XRD) techniques were used. The antioxidant potential of AgNPs was checked by DPPH assay. It revealed maximum 84.76% inhibition of DPPH radical.

Keywords:
Nanotechnology, Green synthesis, Silver nanoparticles, *Prunus armeniaca*

1. Introduction

Nanotechnology has transformed numerous scientific disciplines by introducing innovative solutions in medicine, environmental science, and materials engineering. Among the diverse types of nanoparticles, silver nanoparticles (AgNPs) have gained significant attention due to their wide ranging biological activities, including anti-inflammatory, antimicrobial, and anticancer properties [1, 2]. Beyond these well established functions, the antioxidant potential of AgNPs has emerged as promising area of investigation, particularly for addressing disorders associated with oxidative stress.

Oxidative stress results from an imbalance between reactive oxygen species (ROS) and antioxidant defenses, contributing to a range of pathological conditions such as cardiovascular diseases, neurodegenerative disorders, and cancer [3]. Elevated ROS levels can damage cells by inducing lipid peroxidation, protein degradation, and DNA mutations. Although both natural and synthetic antioxidants have been widely studied, challenges related to their bioavailability and stability have highlighted the need for alternative approaches. Due to their high surface area-to-volume ratio and customizable physicochemical properties, AgNPs have demonstrated considerable potential as effective free radical scavengers [4].

The antioxidant activity of AgNPs is strongly influenced by factors such as particle size, shape, surface charge, and synthesis method. Green synthesis techniques, which employ plant extracts or microbial agents, provide eco-friendly alternatives while also enhancing the biocompatibility and functionality of AgNPs [5]. These biologically synthesized nanoparticles exhibit significant reducing power and free radical scavenging capabilities, largely due to the bioactive compounds present on their surfaces.

Prunus armeniaca, commonly known as an apricot, is a fruit-bearing tree belonging to the Rosaceae family and is renowned for its nutritional and medicinal properties. The apricot is widely cultivated across temperate regions and has been traditionally used in various cultural systems of medicine because of its health-promoting effects. Its applications range from treating respiratory ailments and digestive disorders to supporting skin health and managing chronic diseases [6]. The therapeutic potential of P. armeniaca lies in its rich composition of bioactive compounds, including phenolic acids, carotenoids, flavonoids, vitamins (notably vitamins A and C), and amygdalins. These com-

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pounds possess antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, and anticancer properties [7].

This study investigates the antioxidant properties of silver nanoparticles synthesized using Prunus armenica. This research aims to support the development of AgNP-based therapeutic solutions to combat oxidative stress and its related health challenges.

2. Materials and Methods

2.1. Preparation of apricot extract

P. armenica fruit was purchased from the local market. It was washed to remove dust particles. Further washing was done with distilled water to clean it properly and kept it for drying. Then fruit seeds were removed, and fruit was cut into small pieces. 50 g of apricot fruit was boiled in 500 ml of distilled water for 30 minutes at 60 °C in a water bath. *P armenica* fruit extract was cooled, filtered by using a sieve and kept in refrigerator for further use.

2.2. Green synthesis of silver nanoparticles

80 ml of 3 mM solution of silver nitrate was added in 10 ml *P. armenica* fruit extract. The mixture was stirred for 2 hours at 60 °C. The color of solution was changed from pale yellow to dark brown indicating the formation of silver nanoparticle. The mixture was centrifuged for 30 mints at speeds of 8000 revolutions per minute (rpm). After that silver nanoparticles were collected and stored.

Figure 1: Schematic diagram for Green synthesis of AgNPs

2.3. Characterization of silver nanoparticles

Spectral studies of AgNPs were done by UV-Vis and FTIR spectroscopy. Repeated time scans were performed between 200-800 nm with UV-Visible spectrophotometer (Lambda 25, Perkin Elmer, USA) to determine the synthesis of AgNPs. The FTIR analysis of AgNPs was performed using potassium bromide (KBr) pellet method in a ratio of 1:100 and the spectrum was recorded on Shimadzu FTIR spectrophotometer in transmission mode. Morphological evaluation of silver nanoparticles was carried out using SEM and XRD techniques. The images of AgNPs were obtained on a Field Emission Scanning-Electron Microscope (FE-SEM, JSM7500F) at an accelerating voltage of 10 keV.

The crystalline structure of the biosynthesized AgNPs was checked through powder x-ray diffraction method by using a Rigaku Multiflex X-ray powder diffractometer involving CuKα radiation (0.154nm) operating between 10°and 80°at the scanning rate of 2°per min. The crystalline size was then calculated by using Scherrer´s equation.

2.4. Antioxidant activity of silver nanoparticles

The antioxidant activity of synthesized nanoparticles was determined by DPPH (2, 2-diphenyl-1-picrylhydrazyl) assay by following procedure [8]. Different concentrations of AgNPs 25, 50, 75, 100 μg/mL were used. 1 mL of nanoparticles solution was added to 3 mL of 0.1 mM DPPH solution. This mixture was kept for 30 minutes at incubation in dark. The absorbance was noted at 517 nm. Ascorbic acid was used as positive standard. Reaction was run in triplicate.

3. Results and Discussion

3.1. Characterization of AgNPs

3.1.1. Spectral examination of AgNPs

Silver nanoparticles were characterized by UV-Visible spectroscopy. Figure 2 represented the UV-Visible spectra of synthesized AgNPs which was plotted as a function of time. It clearly revealed the strong resonance centred at 430 nm with increased intensity in 90 minutes. The color change from yellow to brown started in 30 mint and remain persistent after 90 minutes representing the completion of reduction of silver ions. Similar color changes have been noticed in the reported literature [9]. The flavonoids present in the plant extract are responsible for reduction of silver ions in silver nitrate solution [10]. It is evident from literature that AgNP showed UV-Visible absorbance in the range of 428-430 nm [11, 12].

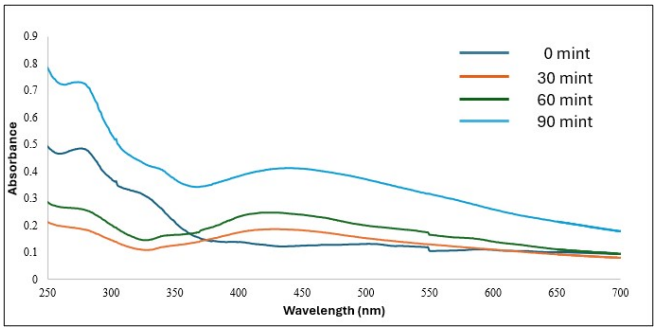

Figure 2: UV-Visible Spectra of AgNPs synthesized by *P. armenica* fruit extract

FTIR analysis was used to identify the various functional group involved in reduction of Ag to AgNPs. FTIR spectrum shown in figure 3. The peak at 3326 cm^{-1} assigned to OH vibration of phenolic content in fruit extract. Apricot fruit is a rich source of phenolics including catechin, epicatechin, chromogenic and neochlorogenic acids [13]. The peak at 1718 cm^{-1} assigned to C=O stretching vibrations of carbonylic moiety in the fruit extract. The band at 1341 cm^{-1} was associated with

the C-H bending vibrations of methyl group. The C-O stretching peak appeared at 1010 cm^{-1}. While the peak at 830 cm^{-1} attributed to C-H bending vibrations.

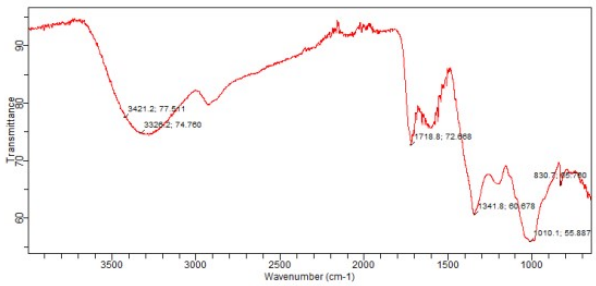

Figure 3: FTIR Analysis of silver nanoparticle

3.2. Morphological examination of AgNPs

3.2.1. Scanning Electron Microscopy

The morphology of silver nanoparticles was determined by SEM images which are shown in Figure 4. SEM images taken at various resolutions illustrated that the silver nanoparticles are spherical in shape highlighted by green circles in figure 4. SEM images also confirmed the formation of individual AgNPs along with some aggregates of AgNPs.

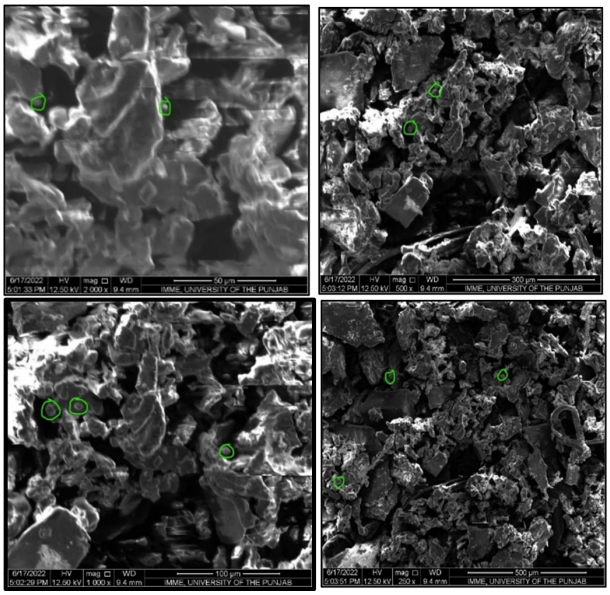

Figure 4: Scanning Electron Microscopy images of silver nanoparticle at various resolutions

3.2.2. Energy Dispersive Spectroscopy analysis

The formation of silver nanoparticles by biological reduction was further confirmed by EDS spectra. In EDS analysis various areas had been focused and corresponding peaks are shown in figure 5. EDS spectra clearly indicate the presence of Ag in tested material. The presence of oxygen may be due to the adsorption of extracellular organic moieties on the surface of nanoparticles. The presence of Mg and K was due to the X-ray emission of different minerals present in apricot fruit extract [14].

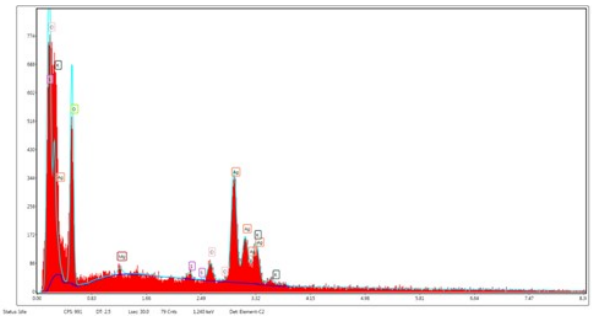

Figure 5: Energy Dispersive Spectrum of silver nanoparticle

3.2.3. X-Ray Diffraction Analysis

The crystalline structure of the bio-synthesized AgNPs was confirmed through powder X-ray diffraction (XRD) analysis as shown in Figure 6. The presence of silver nanocrystals was indicated by distinct Bragg reflection peaks observed at 20 values of 38.82°, 44.06°, 64.19°, and 77.21°, corresponding to the (111), (200), (220), and (311) crystallographic planes, respectively. These findings suggest that the synthesized AgNPs exhibit a face-centered cubic (fcc) structure. The same XRD pattern has been reported by Garibo et al., 2020 [15].

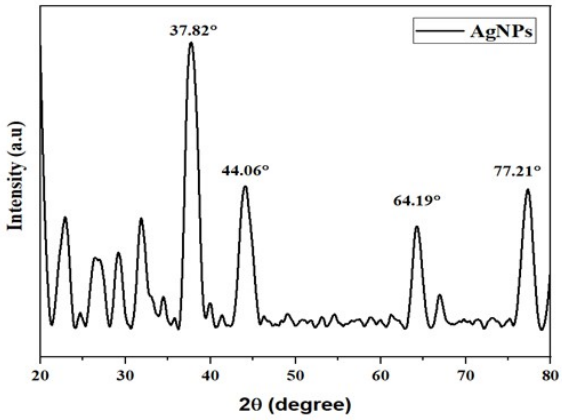

Figure 6: XRD pattern of biogenic Ag nanoparticles crystal structure of silver

3.2.4. XRD pattern of biogenic Ag nanoparticles. crystal structure of silver

Silver nanoparticles prepared by using fruit extract of P. armenecia inhibited DPPH radical, results are shown in figure 7. The percentage inhibition was increased by increasing the concentration of AgNPs. The maximum inhibition of DPPH radical was observed 84.76% at a AgNPs concentration of 100 μg/mL which is comparable to ascorbic acid used as positive control. Similar results for antioxidant activity of biogenically synthesized AgNPs have been reported in literature [16, 17].

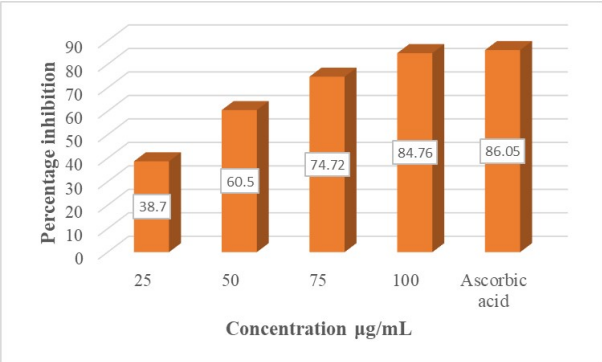

Figure 7: Percentage inhibition of DPPH radical by biogenically synthesizedAgNPs

4. Conclusion

Green synthesis of silver nanoparticles was carried out using Prunus armenica fruit extract. These nanoparticles were characterized by UV-Visible and FTIR spectroscopy. For morphological insight of AgNPs SEM and XRD were used. Results of all these analyses confirmed the successful formation of AgNPs. These nanoparticles were examined for their antioxidant potential, and they inhibited the DPPH radical upto 84.76% which is comparable to standard ascorbic acid. It is concluded that biogenically synthesized AgNPs hava good therapeutic potential and can be further studied against various illnesses.

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