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UV-Visible Spectroscopy and XRD Analysis of Ag Nanoparticles Obtained from *Artemisia Lerchiana* W. Plant Extract

Abstract

The increasing global focus on green nanotechnology research has spurred the development of environmentally and biologically safe applications for various nanomaterials. Nanotechnology involves crafting diverse nanoparticles in terms of shapes and sizes, with a particular emphasis on environmentally friendly synthesis routes. Among these, biogenic approaches, including plant-based synthesis, are favored for their safety, simplicity, and sustainability. Silver nanoparticles, in particular, have garnered significant attention due to their exceptional effectiveness, biocompatibility, and eco-friendliness. *Artemisia Lerchiana* has emerged as a promising candidate for aiding in the green synthesis of silver nanoparticles. Leveraging the phytochemical constituents of *Artemisia Lerchiana*, researchers have successfully tailored silver nanoparticles for a wide array of applications, spanning from biomedicine to environmental remediation. This review explores the properties, synthesis mechanisms, and applications of silver nanoparticles obtained from *Artemisia Lerchiana*. Additionally, it delves into the recent advancements in green synthesis techniques and elucidates the optical properties of these nanoparticles. The structures of the synthesized silver nanoparticles were elucidated by UV-Vis and XRD analyses.

Keywords: *Green synthesis, Ag nanoparticles, Artemisia Lerchiana W., UV-visible spectroscopy, XRD*

Introduction

Nanotechnology aims to create new structures in nanoscale size (0.1–100 nm in diameter) by controlling substances at the atomic and molecular levels. Nanotechnology, which has contributed greatly to developments in medicine, technology, and engineering, has been popular in recent years (Huang H. et al., 2004; Geetha K. et al., 2013). In addition, nanotechnology creates a multidisciplinary working system in areas such as food, agriculture, medicine, and textile together with biotechnology. Nanoparticles can be obtained using different metals (silver, copper, titanium, etc.), among them, silver nanoparticles are preferred because they are natural and not harmful to human health as well as they are used in biomedicals (Zafar et al., 2019; Genc N. et al., 2021). Silver is a noble metal with a long history of use in different forms and for various purposes and has long been known for its beneficial properties acting in wound healing and infections, among others (Alexander, 2009). In comparison to chemical and physical methods, biosynthesis processes are quick, easy, cheap, and, most importantly, efficient and environmentally friendly (Kadhim et al., 2022) In practice, the extract's constituents act as potential capping and reducing agents, limit the over-growth of nanoparticles in colloidal synthesis and prevent their excessive accumulation. These molecules could also affect and improve the characteristics of the resulting nanoparticles by enhancing the performance of these molecules to make them more suitable for a variety of applications (Mohamad et al., 2014). Biogenic synthesis of nanoparticles, particularly plant-based nanoparticle synthesis, appears to be a more efficient process because it does not use risky or dangerous chemicals, as utilized in organic synthesis, to generate nanoparticles (Bar et al., 2009). Silver nanoparticles (AgNPs) stand out due to their intrinsic properties such as high stability, strong absorption in the visible ultraviolet region, and broad potential for applications, which are made possible by the significant surface/volume ratio that gives nanoscale particles different attributes to

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those on a larger scale. In turn, the shape, size, distribution, and surface-related aspects of AgNPs are determined by the concentrations of reducing agents, metal precursors, and stabilizers used during synthesis (Ali et al., 2022; Parmar et al., 2022).

Research

Materials

2.1 Preparation of wormwood extract and silver nitrate ($AgNO_3$) solution

In order to get the plant extract have been used the vegetative organs of *Artemisia lerchiana* Web. Plant samples were collected from Lokbatan settlement of Absheron region of Azerbaijan in the summer season (fig 1). The samples were washed several times first with tap water and then with distilled water. The leaves of plant samples were dried in room conditions for 48 hours. 50 g of dried plant leaves were placed in a 500 ml beaker, then 250 ml of distilled water was added, and the mixture was boiled. The mixture is boiled for 5 minutes to get the desired result. Then the extract was cooled to room temperature. Filtering of the plant extract was done with No. 1 Whatman filter paper. The obtained extract was stored at +4 °C until experiments. In order to obtain silver NPs, a solution of silver nitrate was prepared in the following proportion: 25 grams of salt were dissolved in 300 ml of distilled water.

A B

Figure 1. Map representing the site from where the samples of *Artemisia Lerchiana* were collected. (A) Map of Absheron, (B) location of Lokbatan.

2.2 Biosynthesis

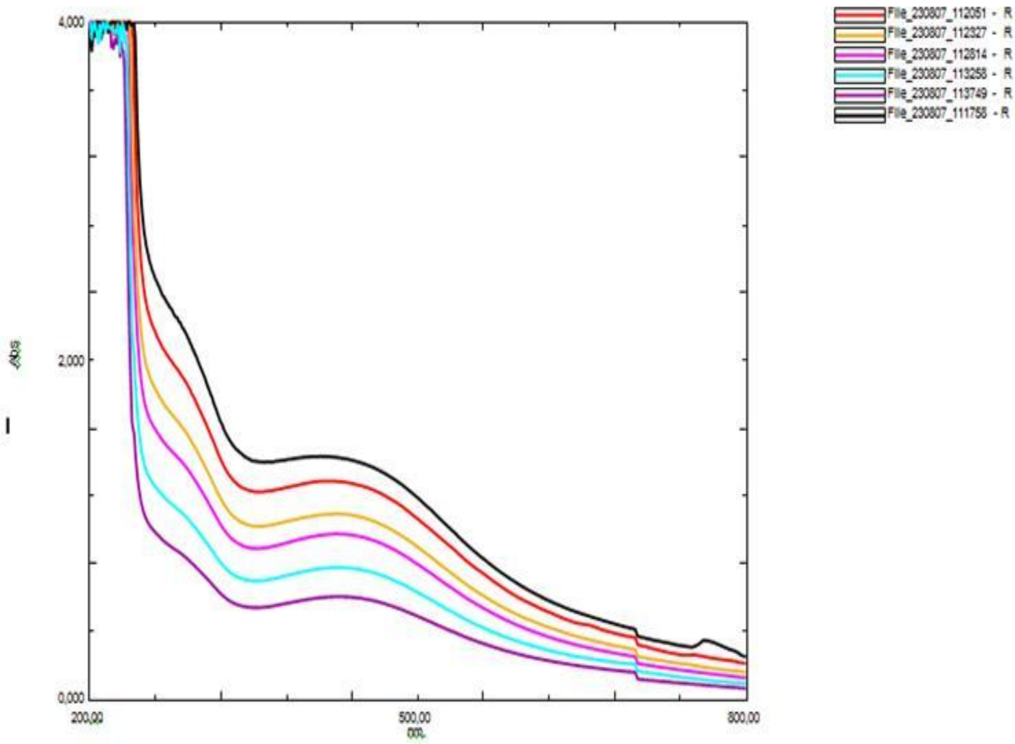
50 ml extract of wormwood leaves and 250 ml $AgNO_3$ solution were placed in a 1000 ml flask and reacted at 45 °C after just shaking by hand. The reaction mixture was found to change color with time. The extract obtained as a result of the reaction was centrifuged at 6000 rpm for 15 minutes with an OHAUS FC 5706 device. After several washings, the precipitated solid was dried in an oven at 75 °C for 24 h. The obtained particles were then prepared for characterization. Phytochemicals in plant extracts reduced Ag^{+1} to Ag^0, thus forming AgNPs.

3. Characterization Results

3.1 UV-visible spectroscopy

The visible color change in AgNPs requires the reduction of Ag ions in nitrate ($AgNO_3$). The reaction mixture containing $AgNO_3$ and *Artemisia Lerchiana* extract resulted in the formation of *Artemisia Lerchiana*-AgNPs, which turned into a dark color. UV-vis spectral analysis is used to obtain information about AgNPs. In the absorption spectrum of AgNPs, the resonance band of the hazard plasmon appears in a wide range of 200–800 nm, with a strong absorption band observed at 480 nm (figure 2).

Figure 2. Maximum absorbance value with UV-vis spectrophotometer as a result of interaction of *A. Lerchiana* plant extract and $AgNO_3$ solution



In various studies, the process of conversion of Ag^+ ions into AgNPs has been confirmed using UV-Vis spectroscopy. The UV–Vis absorption spectra of the plant extract the Ag NPs synthesized using *H. muticus* extract were recorded. The spectra showed an obvious absorption peak for Ag NPs between 400 and 500 nm, with a clear peak around 450 nm for all samples in water solvent (Seyyed et al., 2025). In *Senna auriculata* flower extract silver ions were transformed into silver particles, and then the colour changed from yellow to dark brown. The UV–visible spectrum of the synthesized AgNPs was measured at 420 nm has the highest absorbance peak, which was observed at 424 nm, respectively. UV-Vis spectra of the silver surface plasmon resonance band in the aqueous extract of Rubus sanctus Schreber leaves were observed at 436 nm (Hulya, 2025)

3.2 X-ray diffraction (XRD) analysis

The XRD results revealed that the AgNPs prepared by reducing Ag ions with aqueous extract were naturally crystalline and that the X-ray diffraction represented the presence of the characteristic peaks of the XRD pattern that the synthesized material consisted of nanoscale particles. When X-ray light is reflected on any particles, it creates a plethora of diffraction peaks, which represent the physicochemical properties of the crystalline lattice (Bar et al., 2009). Scherrer's formula ($D = K\lambda/\beta \cos \theta$) was used to calculate the average particle size of AgNPs in the *Artemisia lerchiana* Web. plant extract. An intense peak at 2θ 38.04° was chosen to calculate the crystal size, where K is the Scherrer constant, λ is the wavelength of the light used for diffraction, β is the FWHM value of the peak, and θ is the Bragg angle. The Scherrer constant (K) in the formula above takes into account the shape of the particle and is generally taken to have a value of 0.9. As a result of calculations, it was determined that the average crystal size of silver nanoparticles is 24.83 nm (Fig. 3).

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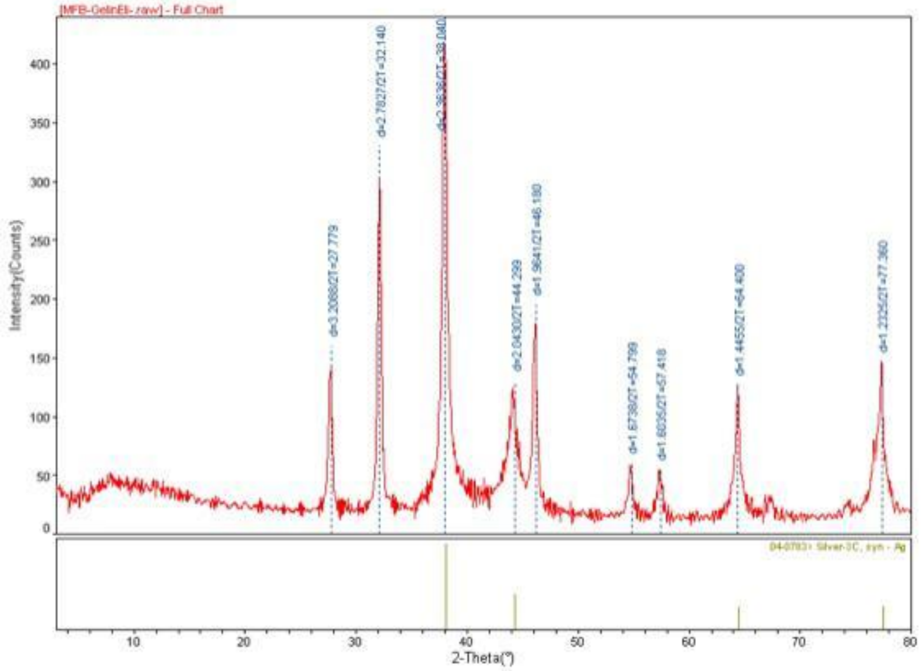

Figure 3. XRD analysis of AgNPs obtained by *A. lerchiana* plant extract

According to the XRD spectrum data of *Artemisia Lerchiana*-AgNPs, the diffraction peaks are at 27.77°, 32.14°, 38.04° , 44.29°, 46.18°, 54.79°, 57.4° , 64.40°and 77.36°, which indicates that silver is cubic represents the crystal structure in the 2θ plane (index).

Several other studies have been conducted. The size of the synthesized silver nanoparticles using Aloe fleurentinorum extract was determined to be 26.87 nm (Yasmin et al., 2024) *Carissa carandas* leaf extract shows the crystalline structure of AgNPs and the size was estimated to be 25.4 nm using Scherrer's formula (Rahuman, 2021).

Conclusion

In conclusion green synthesis method was carried out in biophysical analysis of nanoparticles obtained from Artemisia Lerchiana plant. As a result of UV-Vis spectroscopy, the plasmon resonance peak of the nanoparticles was observed at a wavelength of 480 nm, which confirms the formation of Ag nanoparticles. Based on XRD (x-ray Diffraction) analysis, the crystallite size of the nanoparticles was determined to be 24.83 nm. These results indicate that the Ag nanoparticles synthesized with Artemisia Lerchiana extract have a stable and nanoporous structure.

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